WATER RESOURCES PLAN

Clarke County
Comprehensive Plan
Implementing Component
Article 5

CLARKE COUNTY COMPREHENSIVE PLAN

CHAPTER III-5

WATER RESOURCES PLAN

ARTICLE 5a
GROUNDWATER RESOURCES PLAN
ADOPTED OCTOBER 20, 1998

ARTICLE 5b
SURFACE WATER RESOURCES PLAN
ADOPTED DECEMBER 7, 1999

✓ rec'd

Preface

The Clarke County Comprehensive Plan establishes basic land use policy for the County. The critical nature of water resources to public health as well as the overall environment warrants the establishment of a Water Resources Plan to implement the goals, objectives, and policies of the County Comprehensive Plan.

Water resources include both ground and surface waters. These water features are integrally linked together by the hydrologic cycle: water moves from the atmosphere to the surface as rain; rain then percolates through the soil to groundwater and is discharged at springs to streams, becomes surface water, and evaporates back to the atmosphere. Land use practices have an impact on the quality and quantity of these water features.

The Groundwater Resources Plan, Article 5a of the Water Resources Plan, specifically addresses issues relating to groundwater, including groundwater contamination from nonpoint sources, protecting the Prospect Hill Spring water supply, and increasing public understanding of the sensitive nature of limestone geology.

Surface waters in Clarke County include the perennial secondary streams, the Opequon Creek and the Shenandoah River. The Surface Water Resources Plan, Article 5b of the Water Resources Plan, addresses issues relating to surface waters. These include surface water contamination from point and nonpoint sources, off-stream water use such as domestic supply and irrigation, and recreational uses.

The Surface Water Resources Plan was developed, in part, from a draft Water Resources Plan developed by the Lord Fairfax Planning District Commission in 1990. It has been updated and expanded to reflect current planning efforts, and original text has been cited where appropriate.

GROUNDWATER RESOURCES PLAN

Adopted

October 20, 1998

Clarke County
Comprehensive Plan
Implementing Component
Article 5a

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Executive Summary: Groundwater Resources Plan

The Groundwater Resources Plan is one of two sections of the Water Resources Plan, is an implementing component of the Clarke County Comprehensive Plan. This section specifically addresses issues relating to groundwater, including groundwater contamination from nonpoint sources, protecting the Prospect Hill Spring water supply, and increasing public understanding of the sensitive nature of limestone geology. The Groundwater Resources Plan is designed to accomplish Objective 3 in the Comprehensive Plan, which states: "Protect natural resources, including soil, water, air, scenery, and fragile ecosystems."

The following actions are recommended to implement the Plan:

I. County Ordinances: Review and update County ordinances related to groundwater protection.

A. Septic Ordinance:

1. Phase out nonstandard waste disposal systems such as pit privies.
2. Implement regular maintenance, cleaning, and reporting of septic systems.
3. Identify acceptable alternatives to septic systems when failed or inadequate systems are identified. Installation and use of alternative systems should be accompanied by a maintenance schedule that is regulated by the Clarke County Sanitation Authority.

B. Sinkhole Ordinance: Amend the ordinance to require vegetative buffering of all Class1 sinkholes subject to contamination.

C. Underground Storage Tank (UST) Ordinance: Create a database of the locations of all USTs in the County, and develop a County ordinance that will serve to regulate USTs with less than 1,100 gallons capacity that are used for petroleum or chemical storage.

D. Storm Water Resources Ordinance: Revise the ordinance to better address runoff quantity and quality so as to protect surface and groundwater from contamination.

II. Natural Resources Overlay District: Consider enlarging the district to incorporate the entire groundwater recharge area for Prospect Hill Spring, as delineated by the available data.

III. Public awareness and education: Designate the Clarke County Natural Resource Planner as the County official responsible for public education concerning protection and conservation of groundwater resources.

IV. Nonpoint pollution: Cooperate with and encourage use of the programs administered by the Agricultural Extension Office and other agencies involved in developing Best Management Practices (BMPs).

V. Well testing: Establish a Countywide well-monitoring network to effectively monitor changes in water quality over time. Including routine testing of specific wells for coliform and water chemistry.

VI. Groundwater database development:

A. Develop a database of all existing well and septic permits on file in cooperation with the Health Department. Homes with systems not on file should be surveyed to determine the type and location of water source and sewage disposal.

B. Compile existing data from all previously conducted groundwater studies.

C. Use the GIS to identify and map areas sensitive to groundwater contamination, and utilize this information to prioritize areas in need of increased protection measures.

I. Introduction
The groundwater resources of Clarke County are particularly susceptible to contamination resulting from human activities because of the sensitive nature of the aquifers, found in carbonate rocks underling the Valley region of the County. Groundwater protection and management problems are generally greater in areas that are underlain by carbonate rocks, such as limestone and gypsum, than in areas underlain by most other rock types because of the presence of solution-enlarged sinkholes, conduits, and caves. These geologic features characterize what is called karst terrane. The generally high permeability of these rocks facilitates the infiltration and transport of contaminants from the land surface to the groundwater reservoir.

To minimize the effects of future growth and development, the Clarke County Planning Commission established a Water Study Committee in 1985. This committee directs plans and studies aimed at protecting the water resources of the County. Accomplishments of this committee include the creation of the Clarke County Groundwater Protection Plan (1987), which, in addition to describing the sensitivity of Clarke groundwater, proposed (1) an ordinance that limits land use around sinkholes, (2) septic system installation guidelines, and (3) water-well construction regulations. The Groundwater Protection Plan is a precursor to this Groundwater Resources Plan. These efforts were accompanied by a study sponsored by the American Farmland Trust to map the county's land and natural resources using a geographical information system (GIS) (Maizel and White, 1988). The committee also contracted with the U.S. Geological Survey (USGS) to conduct an in-depth study of the hydrology and quality of groundwater to assist in land use and planning decisions made in the County. This study produced the Water Resources Investigation Report 90-4134, entitled Ground-Water Hydrology and Quality in the Valley and Ridge and Blue Ridge Physiographic Provinces of Clarke County, Virginia (Wright 1990).

II. Purpose and Scope
Three-fourths of the people in Clarke County depend on groundwater as the source of their drinking water. Protecting the groundwater from contamination, therefore, has been of primary importance in the County for many years. The need to protect public health as well as the economic impact for doing so was highlighted in 1981, when the Town of Berryville had to abandon its public water supply wells as a result of contamination from an infiltration of nitrates, phenols, and herbicides, none of which could be traced to a single point source (Wright 1990). Because new wells might later become contaminated, and purification of existing wells was determined to be impossible, the Town decided to draw water from the Shenandoah River, a decision that necessitated construction of a $1.3 million plant to treat the water. This plan is intended to reduce the need for such significant public expenditures.

This plan is designed to address Objective 3 in the Comprehensive Plan, which states: "Protect natural resources, including soil, water, air, scenery, and fragile ecosystems." Although integrally linked, groundwater is the focus for protection in the context of this plan. Protection and management of surface waters features, including the Shenandoah River, Opequon Creek, and the secondary stream network, are addressed in the Surface Water Resources Plan section of the Water Resources Plan.

When Clarke County began working on groundwater protection in 1983, there was very little available in terms of models. An important document published in November 1986 by the Virginia Water Resources Research Center: Protecting Virginia's Groundwater: A Handbook for Local Government Officials (Hrezo and Nickinson 1986). It sets out clearly the role of local government in groundwater protection:

> Because human land use activities cause most groundwater pollution, local governments have a special role to play in protecting this resource. The foundation for this role rests on the responsibility of localities to protect the public health, safety and welfare; their delegated authority to manage land use practices; and their featured place in EPA's groundwater management strategy. Although groundwater protection is every citizen's responsibility, it is the role of local government to provide the leadership needed to assure the good quality of this vital and vulnerable resource, (p. 1).

The handbook states succinctly: Groundwater is a vulnerable resource whose quality is largely determined by how people use land, (p. 3).

III. Description of Resources

Clarke County's location at the junction of two distinct regions-the Valley and Ridge and the Blue Ridge physiographic provinces (figure 1)-creates two different hydrogeologic regions, underlain by characteristic bedrock types. Bedrock in the Valley region consists of carbonates (limestones and dolomites) and calcareous shales; in the Blue Ridge region, it consists of metamorphic basalt, sandstone, quartzite, slate and shale. The rocks of the Blue Ridge are more resistant to weathering and erosion, and this resistance is expressed in the more mountainous terrain, compared to the Valley region (Wright 1990).

Differences in resistance to weathering are also shown by the extent of bedrock openings where groundwater occurs and moves. In the Blue Ridge bedrock, water occurs in fractures in the rock, joints, faults, and bedding plane separations. In the Valley region, the carbonate bedrock is more easily dissolved by water, and many fractures can become enlarged into solution channels.

Enlargement of fractures by dissolution is one feature characteristic of karst topography, which is formed on limestone, gypsum, and other rocks by dissolution and is characterized by sinkholes, caves, and underground drainage (Wright 1990). Compared to other karst regions of the world, Clarke shows a relatively minor degree of karstification, in that the bedrock solution channels, sinkholes, and other features are not as extensive or well developed. The karst features do, nevertheless, greatly influence Clarke's groundwater resources. One important effect is that well developed aquifers, which are characterized by solutionally enlarged bedrock fractures, cause discharges from springs in the Valley region to be greater than those in the Blue Ridge region. Another important influence is the presence of springs and sinkholes, which provide direct connections between the land surface and groundwater (figure 2). Sinkholes, especially, offer an easy way for surface water contaminants to reach groundwater. In addition, new sinkholes can occur when the soil overburden collapses following groundwater pumping. Aquifers are recharged primarily by precipitation infiltrating the soil and reaching the water table. Some recharge also comes from irrigation and septic water. Springs, on the other hand, represent areas of groundwater discharge or the removal of water from an aquifer. Discharge

Figure 1

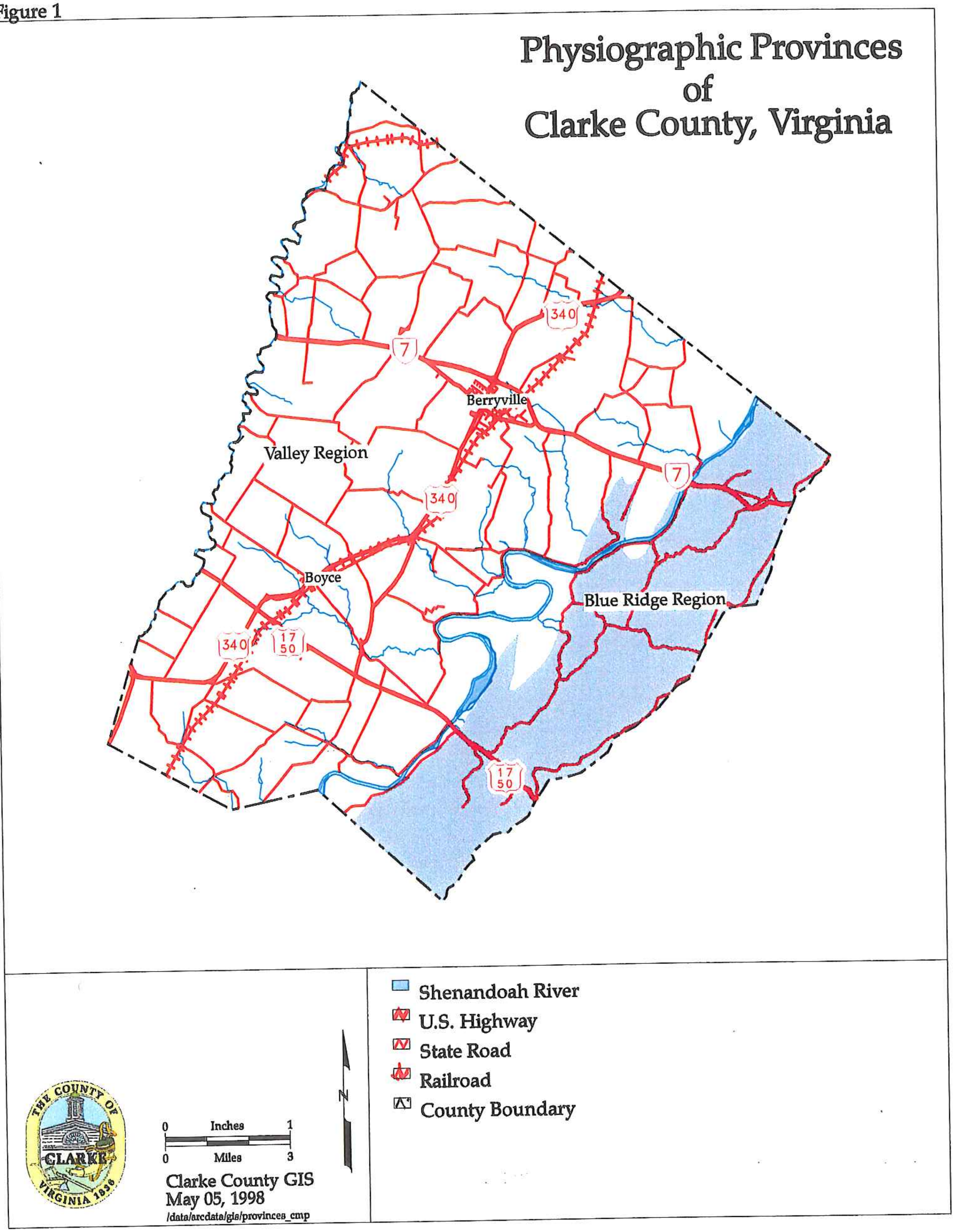
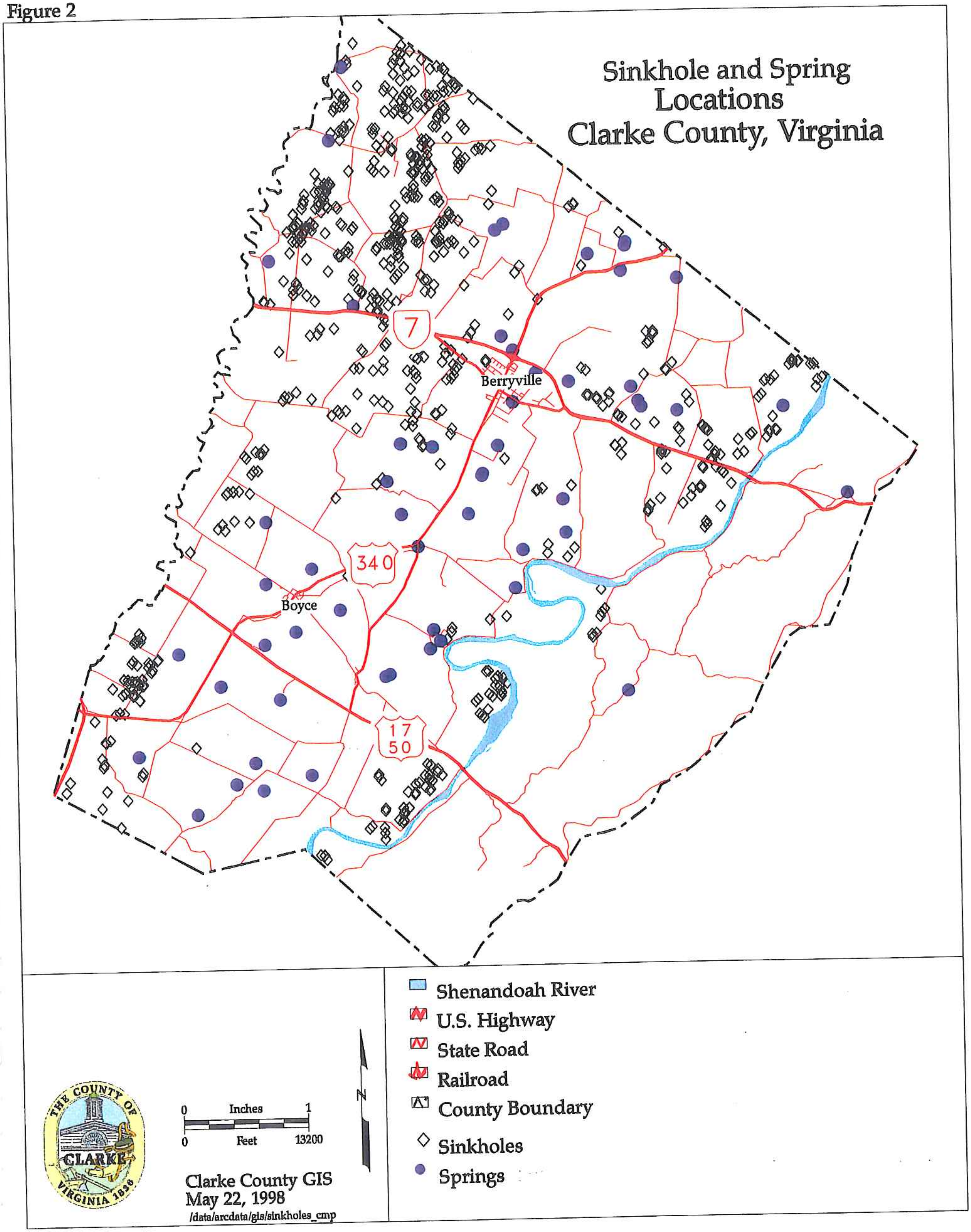

Physiographic Provinces of Clarke County, Virginia
340
7
Berryville
Valley Region
7
340
Boyce
Blue Ridge Region
340
17 50
17 50
Shenandoah River
U.S. Highway
State Road
Railroad
County Boundary
THE COUNTY OF CLARKE VIRGINIA 1836
0 Inches 1
0 Miles 3
N
Clarke County GIS
May 05, 1998
/data/arcdata/gis/provinces_cmp

Figure 2



Sinkhole and Spring
Locations
Clarke County, Virginia
Berryville
Boyce
7
340
17
50
Shenandoah River
U.S. Highway
State Road
Railroad
County Boundary
Sinkholes
Springs
0
Inches
1
0
Feet
13200
N
THE COUNTY OF
CLARKE
VIRGINIA 1836
Clarke County GIS
May 22, 1998
/data/arcdata/gis/sinkholes_cmp

also occurs due to water use by plants, input of groundwater to stream beds, and pumping from wells. Changes in the relative amounts of recharge and discharge appear as fluctuations in the level of the water table (Wright 1990).

Understanding groundwater flow patterns is critical for developing land use protection strategies, as the direction of water movement will dictate where areas highly susceptible to contamination are located. Water table hydrographs -graphs of the water table level over time- were made in 1987 as part of the USGS study. The hydrographs indicate that groundwater flow in most of the Valley region is a combination of diffuse and conduit like flow, with groundwater moving through many small, braided conduits and fissures. The bedrock fractures have been enlarged by dissolution, allowing groundwater to move more easily than it does in the Blue Ridge region, where movement occurs through smaller fractures in more-resistant metamorphic rock (Wright 1990). The specific direction of local groundwater flow is influenced by the fractures in the surrounding bedrock. As well as moving generally down gradient (i.e., perpendicular to contours of equal hydraulic potential), water moves toward areas of greater relative permeability, and fractures are more permeable to water than solid rock. Within the Blue Ridge region, another influence on groundwater flow is the steep terrain, which can cause infiltrating surface water to move quickly to springs or streams (Wright 1990).

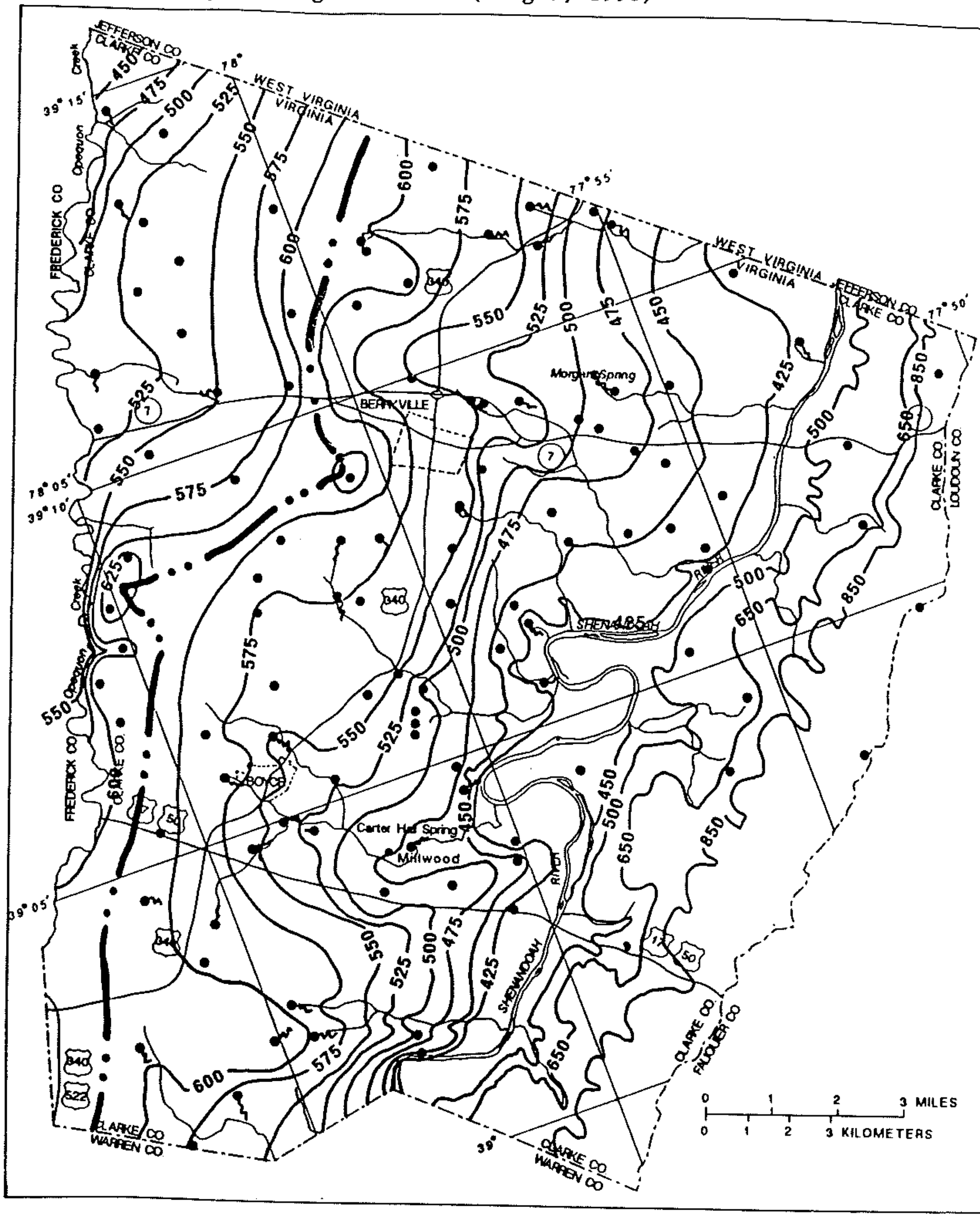
Figure 3 shows the water table contours and groundwater divide (Wright 1990). Flow is generally down gradient (from high to low water table level) toward springs, streams, Opequon Creek, and the Shenandoah River. The divide in the western part of the County separates flows toward the Shenandoah from those toward Opequon Creek.

IV. Groundwater Quality and Contamination Concerns

Water quality refers to the chemical and biological constituents of water. Table 1 lists several of the most important groundwater quality parameters that are affected by both natural and human factors.

Natural groundwater quality depends primarily on bedrock composition. Groundwater in the Valley area has generally higher concentrations of total dissolved minerals, because the rocks of the Valley are more soluble than those of the Blue Ridge. Water from Valley wells and springs has relatively high calcium, low magnesium, and very low sodium and potassium. Water in the Blue Ridge has variable amounts of calcium, low magnesium, and variable (but often high) sodium and potassium. Total hardness ranges from 89-422 milligrams per liter as calcium carbonate (mg/l) in the Valley, compared to 4-242 mg/1 in the Blue Ridge. Valley area groundwater is classified as very hard (Wright 1990). Unnatural groundwater quality or contaminated groundwater is caused primarily by human land uses. Principal land uses in Clarke County include agriculture, forestry, and residential, commercial, and industrial uses (table2).

Figure 3. Contours of the water-surface in Clarke County, Virginia July and August 1987. (Wright, 1990)



EXPLANATION

— 500 — WATER-TABLE CONTOUR--Shows altitude of water-table surface Contour interval 25 feet except in steep terrain east of the Shenandoah River. Datum is sea level

• WELL IN WHICH MEASUREMENT WAS MADE IN JULY OR AUGUST 1987

SPRING WHICH REPRESENTS THE POTENTIOMETRIC SURFACE WHEN FLOWING

GROUND WATER DIVIDE

Table 1. Source and Significance of Selected Constituents of Groundwater in Clarke County, Virginia

CONSTITUENT OR PROPERTY	MAJOR SOURCES	EFFECT UPON USABILITY OF WATER
Calcium (Ca) and magnesium (Mg)	Dissolved from practically all soils and rocks but especially from limestone, dolomite, and gypsum	Cause most of the hardness and scale-forming properties of water; detergent consuming (see Hardness entry, below). A high concentration of magnesium may act as a laxative in humans.
Sodium (Na)	Dissolved from practically all rocks and soils; present in industrial wastes and sewage	In water containing calcium forms hard scale in steam boilers. Secondary maximum contaminant level is 200 mg/l.
Chloride (Cl)	Dissolved from rocks and soils; present in seawater, deep groundwater, sewage and industrial wastes, highway salts, and fertilizers	May impart salty taste above 100 mg/l and increases corrosiveness of water. Secondary maximum contaminant level is 250 mg/l.
Nitrate (NO_3)	Fertilizers and decay with organic matter, sewage, and animal waste	Encourages growth of algae and other organisms that produce undesirable taste and odors. Concentrations in excess of the suggested limit are suspected as a cause of methemoglobinemia (blue baby) in infants. Maximum contaminant level is 10 mg/l as nitrogen.
Hardness as calcium carbonate ($CaCO_3$)	Primarily calcium and magnesium	Consumes soap and synthetic detergents; produces scales in hot water heaters, pipes, and boilers
Fecal coliform and fecal streptococci	Wastes from human and animal intestines	Indicates contamination from human and/or animal waste. Maximum contaminant level is 4 colonies/100 ml.
Specific Conductance	Reflects dissolved mineral content of the water	Indicates the capacity of the water to conduct a current of electricity. Varies with the concentration of ions in solution

Source: Wright 1990.

Table 2. Clarke County Land Use, in Acres

	Rural County	B'ville	Boyce	Total County	Percentages
Single family residential- urban (in incorporated towns)	0	66.3	123.7	189.9	.2 %
Single family residential- suburban (not in incorporated towns, less than 20 acres in parcel)	15,557.5	0	0	15,557.5	14.0 %
Multifamily	5.5	3.8	0	9.3	<.1 %
Commercial/industrial	582.3	162.6	7.5	752.4	.7 %
Agricultural (20 - 99 acres in parcel)	28,091.4	166.6	20	28,278.8	25.5 %
Agricultural (more than 99 acres in parcel)	60,742.8	0	0	60,742.8	54.8 %
Exempt (government, churches, etc.)	4,567.6	506.7	161.2	5,235.5	4.7 %
Total Acreage	**109,547.1**	**906.0***	**312.4***	**110,812.6**	**100.0 %**

From the Clarke County Comprehensive Plan, 1994

Source: Clarke County Commissioner of Revenue, 1993

* Includes entire parcels of which only a majority may be within Town corporate limits

A. Contamination Sources

Table 3 describes the contamination sources associated with principal land uses.

Table 3. Contamination Threats to Groundwater Associated with Principal Land Uses in Clarke County, Virginia

LAND USE	LAND USE ACTIVITY	TYPE OF CONTAMINATION
Agriculture	Animal feed lots, manure spreading and pits, chemical application, and chemical storage areas	Coliform bacteria pesticides, fungicides fertilizers– nitrates
Residential	Septic systems Hazardous household products (paints, cleaning products) Lawn chemicals, fertilizers Underground storage tanks	Coliform bacteria chemicals chemicals, nitrates petroleum
Commercial And Industrial	Auto repair, construction areas, car washes, gas stations, paint shops, road deicing operations, storage tanks, storm water runoff	petroleum chemicals detergents salts
Other uses	Transportation railroad trucking	petroleum chemicals variety of contaminants

Source: U.S. Environmental Protection Agency 1989

B. Contamination Problems

General contamination of wells throughout the County has been documented in multiple groundwater studies. Health Department Records of water samples collected by the Clarke County office of the State Health Department (hereafter referred to as the Health Department) from 1980 to1998 indicate approximately 40% of wells sampled were contaminated by fecal coliform. This number was validated by a groundwater study completed in 1990 by the USGS that also identified 40% contamination rates, and again in 1991 a water testing program conducted by the Agricultural Extension Office showed that up to 40% of sampled wells were contaminated by coliform (figure 4). Since 1992, the Health Department has collected nitrate samples from all new wells installed in the County. Coliform samples are collected by the homeowner, and results are not reliable (figure 5). Additional data have been collected to determine the influence of agricultural chemicals and pesticides (LoCastro 1988). Pesticide data were also collected by the USGS in 1990 and during the Agricultural Extension Service 1991 water survey (Ross et. al. 1992).

Contamination levels prior to the 1960s are not known, but based on the available data it is reasonable to conclude that contamination levels are higher than would occur naturally. This elevated contamination is from an increase both in sources of contamination and in the number of wells located throughout the County. Wells, like sinkholes, are pathways for contaminants to enter the groundwater.

The major known contaminant problems have been caused by nitrates, bacteria, and petrochemicals. Figure 6 shows the location of these problems. Pollution of private wells was recognized as a problem in the 1960's in the Boyce-Millwood area and led to the creation of the Clarke County Sanitary Authority in 1968 (LFPDC 1987). By the mid-1970s, the authority began supplying water to more than 200 residences and businesses from the high-yielding Prospect Hill Spring. According to the 1987 Groundwater Protection Plan: The most costly case for the County citizens was the 1981 loss of the Berryville public water supply wells. The wells had been contaminated by a combination of nitrates, phenols, and herbicides, none of which could be tied to a single point source. Rather than drill new wells which could later become contaminated, the answer to Berryville's water problem was a new $1.3 million water treatment plant using the Shenandoah River as the water supply (p. 1). In the early 1986, 10 wells in the village of Pine Grove were contaminated by petroleum believed to have leaked from underground storage tanks. The contamination of the groundwater supply for the community of White Post by petroleum products necessitated the expenditure of more than $2 million by the State Water Control Board to bring potable water from Prospect Hill Spring to White Post residents in 1992.

Faulty septic systems are one of the most common sources of groundwater pollution. Household waste water contains high levels of nutrients (primarily nitrogen and phosphorus), bacteria, viruses, and household chemicals (Weigmann et. al. 1992). In 1995 the Town of Boyce constructed a sewage treatment plant due to the high number of failing septic systems. An environmental survey performed by the Lord Fairfax Health District (a regional office of the State Health Department) in 1987 stated that 46% of the sewage disposal systems in Millwood did not meet the standards of the Health Department and that human health hazards exist as a result of these inadequacies. This situation not only causes a substandard life style for affected county residents but also presents a significant threat to the quality of groundwater. Efforts are ongoing to bring public sewer service to Millwood. In rural areas of the County, substandard septic systems such as cesspools and pit privies also represent a potential health and environmental hazard. Approximately 188 homes in the County do not have either a septic system or cesspool (Virginia 1990 Census of Population and Housing).

Figure 4

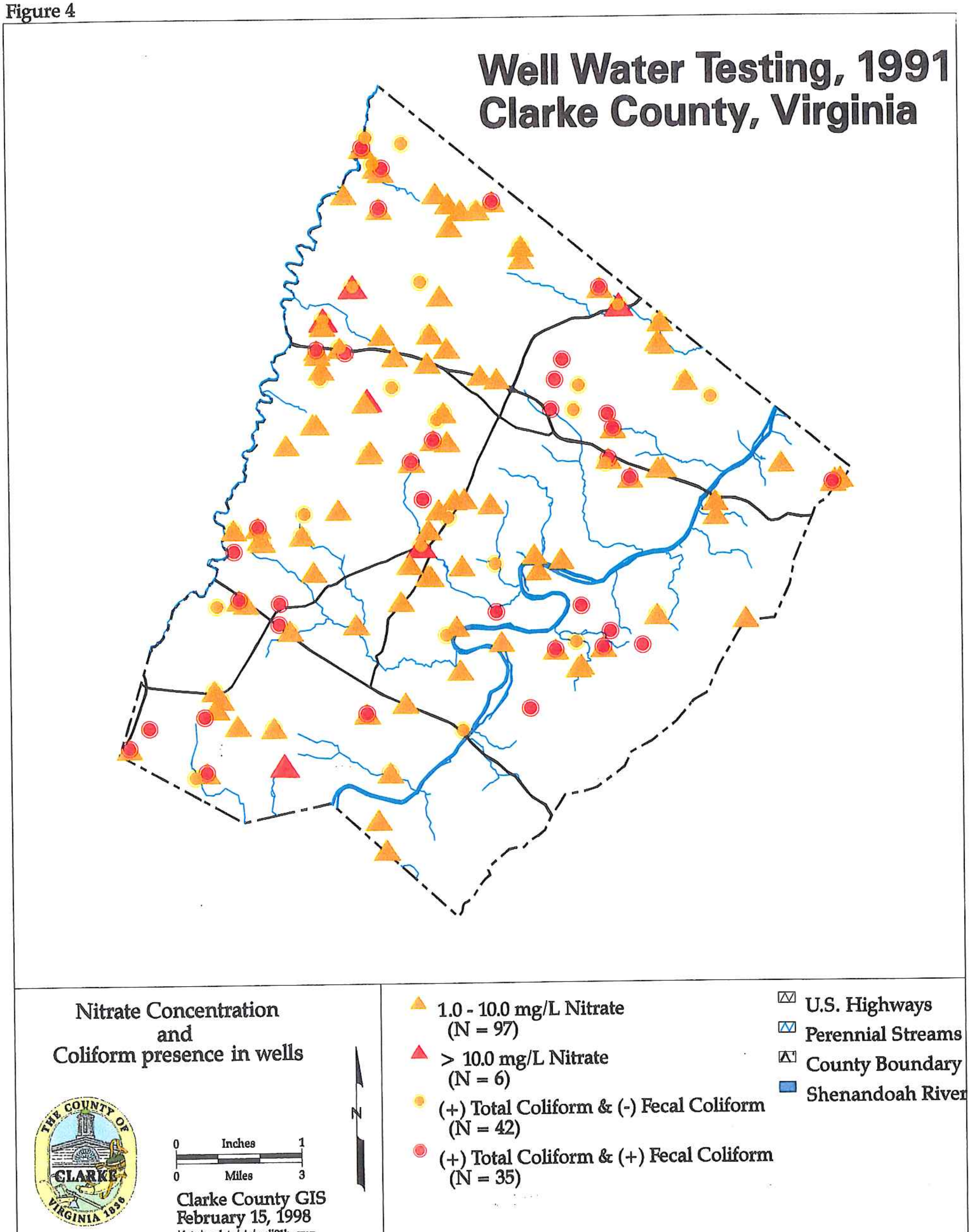

Well Water Testing, 1991
Clarke County, Virginia
Nitrate Concentration
and
Coliform presence in wells
THE COUNTY OF
CLARKE
VIRGINIA 1836
0
Inches
1
0
Miles
3
Clarke County GIS
February 15, 1998
/data/arcdata/gis/well91b_cmp
N
1.0 - 10.0 mg/L Nitrate
(N = 97)
> 10.0 mg/L Nitrate
(N = 6)
(+) Total Coliform & (-) Fecal Coliform
(N = 42)
(+) Total Coliform & (+) Fecal Coliform
(N = 35)
U.S. Highways
Perennial Streams
County Boundary
Shenandoah River

Figure 5

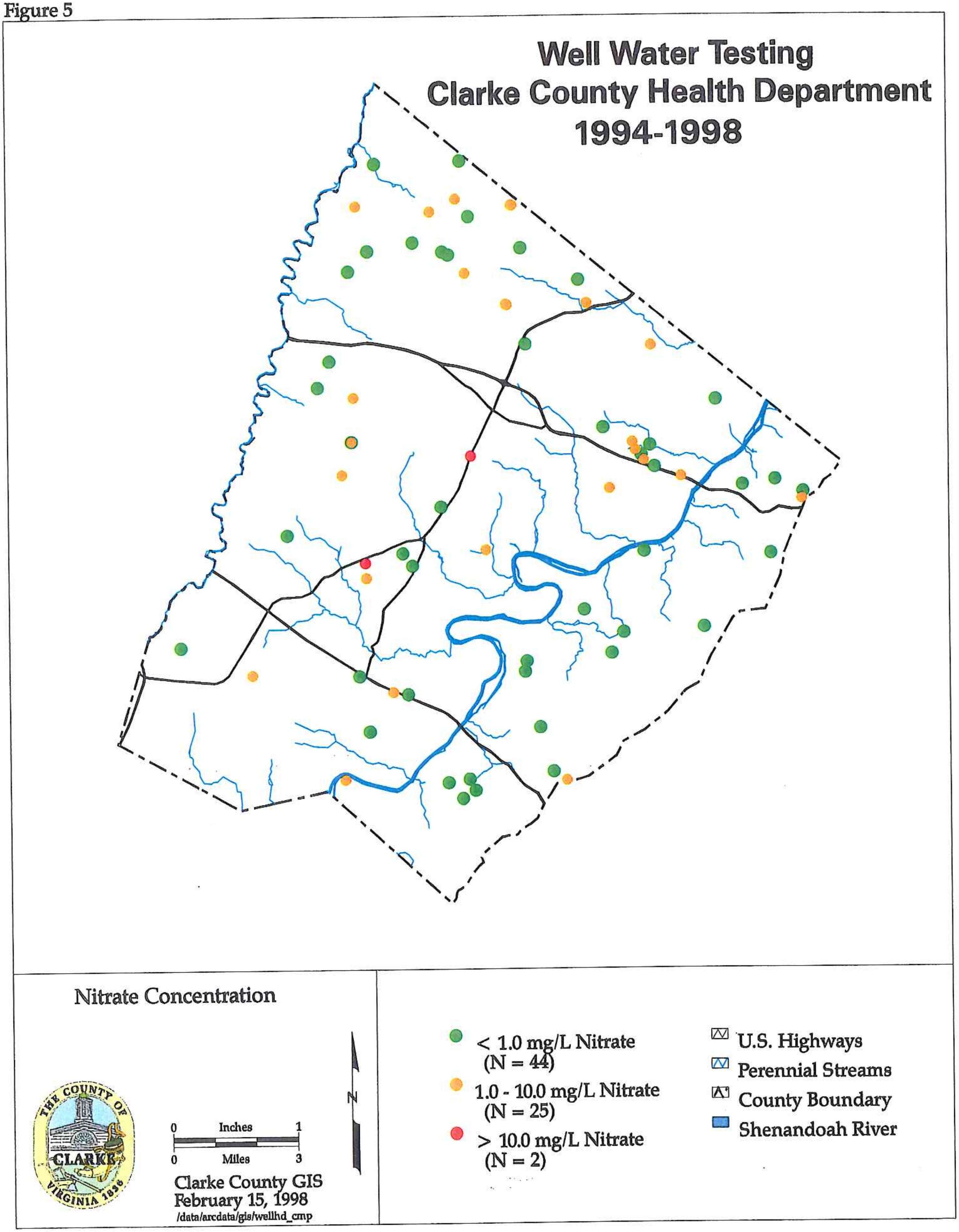
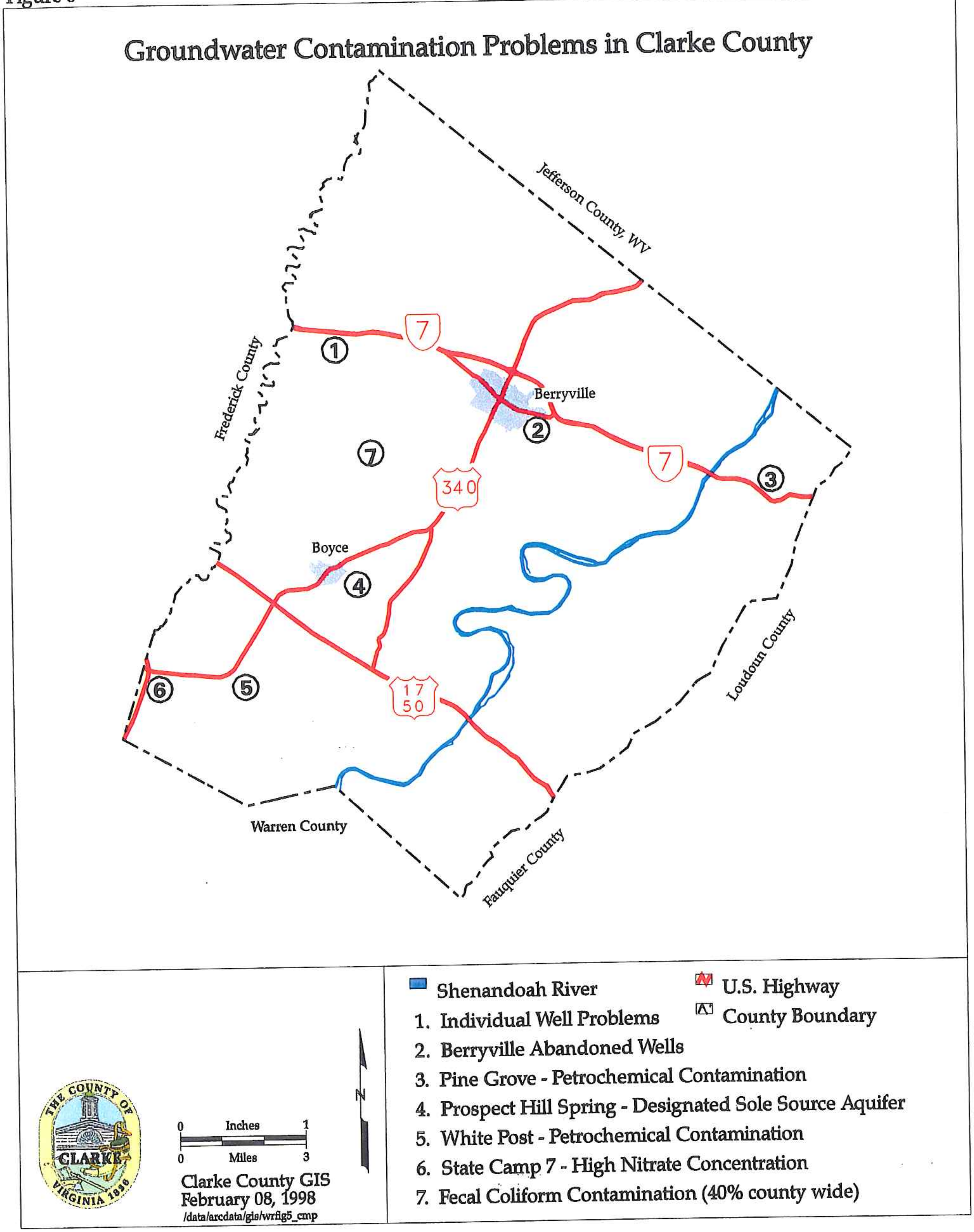

Well Water Testing
Clarke County Health Department
1994-1998
Nitrate Concentration
< 1.0 mg/L Nitrate (N = 44)
1.0 - 10.0 mg/L Nitrate (N = 25)
> 10.0 mg/L Nitrate (N = 2)
U.S. Highways
Perennial Streams
County Boundary
Shenandoah River
THE COUNTY OF CLARKE VIRGINIA 1836
0 Inches 1
0 Miles 3
N
Clarke County GIS
February 15, 1998
/data/arcdata/gis/wellhd_cmp

Figure 6


Groundwater Contamination Problems in Clarke County
Jefferson County, WV
Frederick County
Loudoun County
Fauquier County
Warren County
Berryville
Boyce
7
340
17 50
Shenandoah River
U.S. Highway
County Boundary
1. Individual Well Problems
2. Berryville Abandoned Wells
3. Pine Grove - Petrochemical Contamination
4. Prospect Hill Spring - Designated Sole Source Aquifer
5. White Post - Petrochemical Contamination
6. State Camp 7 - High Nitrate Concentration
7. Fecal Coliform Contamination (40% county wide)
0 Inches 1
0 Miles 3
N
THE COUNTY OF CLARKE VIRGINIA 1836
Clarke County GIS
February 08, 1998
/data/arcdata/gis/wrfig5_cmp

New residential, commercial, and industrial development increases the potential of groundwater contamination from storm water runoff. Storm water management requirements are currently administered at the State level. Most management is directed towards maintaining predevelopment quantity of water leaving a property. Efforts are being initiated at the local government level to filter runoff to improve the quality of water leaving a site.

V. Past Groundwater Mitigation Efforts

Contaminants can move from surface to groundwater through a number of pathways. The most common avenues are wells, sinkholes, or infiltration into shallow overburden (unconsolidated material overlying bedrock, such as loose soil, silt, sand, and gravel) and movement through permeable overburden to fractures in the rock (Wright 1990). Preventing groundwater contamination can be accomplished by: (1) eliminating the contamination source, or (2) buffering or preventing access by contaminants to the groundwater.

Clarke County's past and ongoing efforts to prevent groundwater contamination are directed by the environmental objective described in the County's Comprehensive Plan. Policy 4 under this objective specifically addresses the management and protection of groundwater resources, focusing on two main areas:

1. protecting groundwater Countywide to prevent contamination of the private drinking water supply; and
2. protecting Prospect Hill Spring, which is the only public drinking water facility operated by the County.

A. Countywide Mitigation Efforts

Several State agencies are responsible for protecting Virginia's groundwater. These include the Department of Environmental Quality (DEQ), the Department of Conservation and Recreation (DCR), and the State Health Department. DEQ regulates underground storage tanks (greater than 1,100 gals. capacity), and groundwater withdrawals exceeding 300,000 gals/month within groundwater management areas. Additional regulations address surface waters and air quality. The Department of Conservation and Recreation (DCR) is responsible for administering the Cave Protection Act, which prohibits disposal of solid wastes in sinkholes. DCR also administers the storm water management regulations for the State. The State Health Department regulates sewage disposal and well installation. State regulations address the Statewide need for groundwater protection. Counties have been given the authority to enact regulations stricter than the State to prevent the pollution of water that is dangerous to the health or lives of persons residing in the county (15.2-1200, 32.1-34).

Due to the presence of karst terrane and the identified historic problems with groundwater contamination, Clarke County is more susceptible to contamination than counties in other regions in the state. Therefore, since 1983 Clarke County has adopted and amended ordinances to protect its groundwater resources. County septic, well, and sinkhole ordinances ensure that future growth does not introduce additional risk of groundwater contamination.

In the 1987 Groundwater Protection Plan the need for a County Septic Ordinance is described as follows:

Approximately 4 million gallons of wastewater is discharged each day into the soils and groundwater of Clarke County from an estimated 3000 septic systems serving rural residences, businesses, and institutions. By comparison, the Town of Berryville discharges about .5 million gallons a day of treated wastewater into Dog Run, a tributary of the Shenandoah River. Therefore, septic systems collectively can be recognized as the largest point discharge of wastewater in the County. They present a continuous loading of bacteria and viruses, nitrates, metals, and organic compounds to groundwater. Given the problem caused by improperly installed or failing septic systems, or any other alternative system approved by the Virginia Department of Health, it is recommended that strong standards for the installation and maintenance of such systems be developed and implemented, (p. 11).

The Septic Ordinance was adopted December 15, 1987. As stated in the intent section, the purpose of the ordinance is "to minimize the potential for groundwater contamination resulting from improper siting and construction of subsurface septic systems in Clarke County." Amendments to this ordinance are summarized in Appendix A. County regulations are stricter than the State's primarily with regard to system siting and installation. A summary of the differences between State and County regulations is summarized in Appendix B.

The Groundwater Protection Plan also stated the need for a County Well Ordinance. The concern with wells and groundwater contamination is that improperly cased and grouted wells serve as conduits for surface pollutants to the groundwater. Considering the high number of positive tests for fecal coliform in wells, the immediate vicinity of the well could be the source of pollution; therefore increased setback requirements from contamination sources are included in the County ordinance. The County also wanted to protect groundwater from agricultural wells that are neither cased nor grouted but are located in areas of high concentrations of animal waste (LFPDC 1987). The County Well Ordinance was adopted March 20, 1990, and implemented May 1, 1991. A summary of the amendments to the ordinance is provided in Appendix A. County regulations are stricter than the State's primarily with regard to system siting and installation. A summary of the differences between State and County regulations is summarized in Appendix B.

Sinkholes are identified as points where contaminants can enter the groundwater system. The Clarke County Soil Survey data identify numerous sinkholes in the County (Edmonds and Steigler 1982). <u>The Model Ordinance for Groundwater Protection</u> developed by the Minnesota Project and published in July 1984 contained a sinkhole element that was modified to meet the needs of Clarke County by the County staff (LFPDC 1987). The Sinkhole Ordinance was adopted January 20, 1987. The State regulations prohibit dumping of solid waste into sinkholes. The County regulations go on to define Class 1 and Class 2 sinkholes as well as outlining remediation and penalties for violators.

The 1987 Groundwater Protection Plan drafted Underground Storage Tank Requirements to protect human health and the public welfare by establishing regulations for residential and agricultural underground storage tanks. However, the plan recognized that regulating underground storage tanks is a complex issue and the administration of such a program may be costly for a small local government. Therefore the recommendation of the Plan was to consider implementation should contamination from tanks increase significantly (LFPDC 1987).

B. Prospect Hill Spring Mitigation Efforts

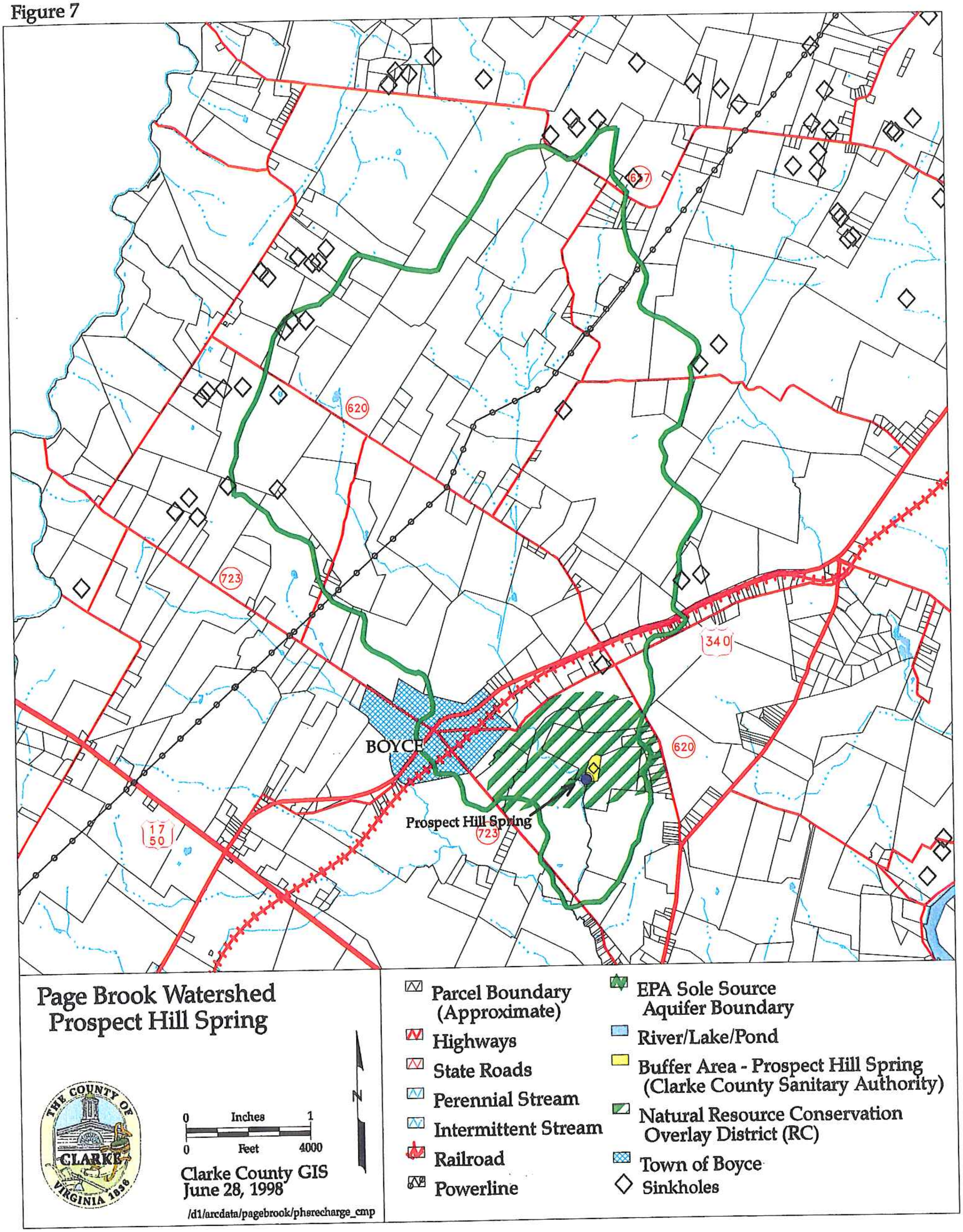
Considerable effort has been and continues to be extended to protect Prospect Hill Spring, the public water supply for approximately 300 households in the Town of Boyce, the Villages of Millwood and White Post, and the Waterloo commercial district.

The spring was permitted by the State Health Department as a public water supply in 1977. Development pressures around the spring in the early 1980s prompted the County to contract two studies to determine the impact of new drainfields on the Spring. The Honkala report (1980) summarized the soils and geology of the area and listed several recommendations that might allow safe development of a limited number of homes. The second study, by Schnabel Engineering Associates (1983), was conducted "to develop general land use policies, guidelines, and recommended restrictions, which will protect the water quality of Prospect Hill Spring in a cost effective manner (p. 1)." This report led to development of the Natural Resource Conservation Overlay District (RC) in 1983 (figure 7). The Overlay District encompasses a 400 acre area within a 3,000 foot arc up gradient from the spring, which the report terms the "Local Recharge Area." A recharge area is defined as regions that are hydrogeologically connected to an aquifer and that contribute significant amounts of water to it (Virginia Groundwater Protection Steering Committee 1991). The intent of the Overlay District is to provide protection of the groundwater recharge area for Prospect Hill Spring; however, the boundary does not encompass what the study refers to as a "major recharge area that would include the surface water drainage basin of Page Brook." This area would encompass approximately 4,900 acres. Collaborating the Schnabel report's finding is the federal designation of the Page Brook's surface water drainage basin as an Environmental Protection Agency (EPA) sole-source aquifer in 1987. In the EPA's final determination, the agency found in part that "The Prospect Hill Spring is the sole or principal source of drinking water for that part of Clarke County, and that such aquifer, if contaminated, would create a significant hazard to public health (p. 21733)". In addition, such designation means that no federal assistance may be provided for any project in the area that the U.S. Environmental Protection Agency finds may contaminate the aquifer.

To continue to define the recharge area, dye tracing studies were conducted in 1987 by W. K. Jones. The tests indicated that groundwater in this area can move two miles or more from recharge points in as little as five months. Since the initial study two additional dye tests have been undertaken. In 1992, Jones was contracted by the County to continue his previous work. Dye was placed in three sinkholes but was never recovered. The lack of recovery was thought to be due to a drought that ensued shortly after the dyes were injected. In 1998, a study was conducted by EPA with dye placed in two sinkholes. The results of this test are not yet available.

Revisions to EPA's Surface Water Treatment Rule in 1989 required the County to go beyond previous protection efforts. The revised rule contains provisions that require disinfection and filtration for all public water systems that use surface water or a source that is groundwater under the direct influence of surface water. Previously springs were considered groundwater sources, requiring disinfection only. Only those systems that were able to demonstrate compliance with the stringent source water quality criteria could avoid the filtration requirement. In June 1994, the State Health Department issued a finding that Prospect Hill Spring is under the

Figure 7


637
620
723
BOYCE
620
Prospect Hill Spring
723
17
50
340
Page Brook Watershed
Prospect Hill Spring
THE COUNTY OF CLARKE VIRGINIA 1836
0 Inches 1
0 Feet 4000
N
Clarke County GIS
June 28, 1998
/d1/arcdata/pagebrook/phsrecharge_cmp
Parcel Boundary (Approximate)
Highways
State Roads
Perennial Stream
Intermittent Stream
Railroad
Powerline
EPA Sole Source Aquifer Boundary
River/Lake/Pond
Buffer Area - Prospect Hill Spring (Clarke County Sanitary Authority)
Natural Resource Conservation Overlay District (RC)
Town of Boyce
Sinkholes

influence of surface waters as demonstrated by high bacteria levels (Eberly 1994). Based on this finding, the County is required to provide disinfection and filtration of the water. Concerned with the potential source of the bacteria, the County contacted W. K. Jones, a consulting hydrologist, and Dr. Charles Hagedorn, a professor of environment microbiology at V.P.I. These scientists independently concluded that cattle grazing in and around a sinkhole 500 feet up gradient of the spring were contributing to the contamination (Hagedorn 1994; Jones 1994). Responding to their conclusions, seven acres of land surrounding a sinkhole directly above the spring was purchased in 1997. The land was fenced to exclude cattle and in 1998 planted with approximately 400 hardwood seedlings so as to establish a permanent vegetated buffer.

VI. Plan Implementation

The County continues to experience residential growth at a rate of almost 2% annually in rural areas. Providing public water service outside of the designated growth areas is economically undesirable. Therefore protecting the quality of groundwater is essential to protect public health. Initial steps taken by County policy makers were focused on reducing groundwater pollution. Based on the anticipated growth, expanded efforts are necessary to address the continued threat to groundwater from existing and future contamination sources.

This plan presents a comprehensive approach to groundwater problems. The underlying assumptions are: (1) protection of natural resources and the environment is everyone's responsibility; (2) land use decisions should be in accord with a sound strategy for protecting the County's groundwater resources.

The County should take action in the following areas: (A) continue to review and update County ordinances related to groundwater protection; (B) reexamine and evaluate of the Natural Resources Conservation Overlay District protecting Prospect Hill Spring; (C) implement a public education program to encourage water conservation and protection by County citizens; (D) develop a response to nonpoint pollution; (E) establish and maintain a Countywide long-term groundwater monitoring network; and (F) develop a groundwater database.

A. Review and update County Ordinances related to groundwater protection.

Since initial publication of the Clarke County Groundwater Protection Plan in February 1987, the County has drafted or put in place ordinances related to groundwater protection in the following areas: (1) on-site waste-water treatment system resources; (2) sinkhole identification and education; (3) water-well construction and water testing; and (4) underground storage tank requirements. These regulations will help to ensure that new construction and development will be done only with necessary protection of the groundwater.

Additional regulations are needed to: (1) Phase out nonstandard waste disposal systems such as pit privies; (2) implement the ordinance requiring regular maintenance, cleaning, and reporting of septic systems; (3) develop an underground storage tank ordinance to regulate storage tanks less than 1,100 gals., which are not regulated by the Virginia Department of Environmental Quality; and (4) revise the Storm Water Resources Ordinance.

1. Septic Ordinance

a. Phase out nonstandard waste disposal systems such as pit privies.
Pit privies installed on poor soils and when used in conjunction with gray water systems represent a significant threat to public health and groundwater quality (Enferadi et. al. 1986). The 1990 census documented 188 households in the County using privies as their primary waste disposal system. Adoption of this ordinance must be accomplished in concert with a program for providing alternatives to those currently using these facilities. Whenever possible, the County should facilitate the work of community improvement organizations such as Help with Housing to provide indoor plumbing to residences in the County or to help upgrade substandard systems such as cesspools.

b. Implement regular maintenance, cleaning, and reporting of septic systems.
Septic systems fail if they are not properly maintained by pumping approximately every five years. Because of the soil qualities in Clarke County, a failed septic system presents a real danger to the quality of the County's groundwater. Many lots with building rights or existing houses within the county do not have an adequate reserve drainfield if a system fails. It is in the interest of homeowners and the county in general to ensure that all systems are adequately maintained. In June 1995 the Board of Supervisors approved a septic system maintenance section requiring pump-out of septic tanks, cesspools, and dry wells. For it to be implemented, a fee schedule needs to be developed and adopted by the Board. Prior to adopting a fee schedule, the administration of the pumpout schedule will need to be addressed. Haulers will be required to provide records of pumping to the Health Department. Consideration should be given to providing an incentive program should homeowners voluntarily pump their tank. Failure to meet this requirement should result in the County having the system pumped and charging the fee to the property owner.

c. Identify acceptable alternatives to septic systems when failed or inadequate systems are identified. Installation and use of alternative systems should be accompanied by a maintenance schedule that is regulated by the Clarke County Sanitation Authority.
Many existing properties within Clarke County are on lots of insufficient size to meet the County's current septic regulations. For example, Millwood has numerous residences on lots that will not support <u>any</u> septic system. Residents of these properties use privies and have no other means of wastewater disposal. Current County ordinances provide for relief from standards for failed systems but do not prescribe what alternative systems are acceptable or recommended.

2. **Sinkhole Ordinance: Amend the ordinance to require vegetative buffering of all Class 1 sinkholes subject to contamination.**
   As stated earlier, sinkholes are direct pathways for surface contaminants to enter the groundwater. Landowners with sinkholes on their properties should be sent educational information to increase their awareness of the potential threat to groundwater.

3. **Underground Storage Tank Ordinance: Create a database of the locations of all USTs in the County, and develop a County ordinance that will serve to regulate USTs with less than 1,100 gals. capacity that are used for petroleum or chemical storage.**

   Underground storage tanks (USTs) with greater than 1,100 gals. capacity for petroleum products and chemicals are strictly regulated by the Virginia Department of Environmental Quality (DEQ). Currently smaller tanks are not regulated. The potential for groundwater contamination of leaking tanks exists for all USTs.

4. **Storm water Resources Ordinance: Revise the ordinance to better address runoff quantity and quality so as to protect surface and groundwater from contamination.**

   Storm water management addresses the runoff from new development. Runoff impacts primarily surface waters and will be addressed more fully in the Surface Water Resources Plan. However, in karst areas impacts to groundwater can also occur.

B. Natural Resources Conservation Overlay District: Consider enlarging the district to incorporate the entire groundwater recharge area for the spring, as delineated by available data.

The Natural Resources Conservation Overlay District was established in 1983. Its intent was to provide greater protection to Prospect Hill Spring that serves as the only water source in the Boyce, Millwood, Waterloo, and White Post area. Since the establishment of the district, the federal government has designated a portion of the recharge area (the drainage basin of Page Brook) of Prospect Hill Spring as a "sole source aquifer." The area of the sole source aquifer encompasses a region significantly larger than the area designated within the Natural Resources Conservation Overlay District. Additional dye testing should conducted to further delineate the groundwater recharge area. To fully protect the springs water supply, the boundaries of the district should be expanded to incorporate the entire groundwater recharge area for the spring, as indicated by this testing.

C. Public awareness and education: Designate the Clarke County Natural Resource Planner as the County official responsible for public education concerning protection and conservation of groundwater resources.

Public education is an essential component of any attempt to protect and conserve groundwater resources. Scientific evidence demonstrates that human activities present the largest threat to Clarke County groundwater. Public education is needed in the following areas: (1) overview of the special nature of Clarke County groundwater dynamics and migration of contaminants; (2) groundwater contamination from inadequate and failing septic systems; (3) groundwater contamination from agricultural sources; (4) groundwater contamination from household toxins; (5) need for water conservation and use of conservation devices; and (6) education for property transfers - what are the existing water and sewage disposal systems, and how should they be maintained.

This plan recommends that appropriate materials concerning the above topics be developed and disseminated to the general public. Materials may be distributed at the time of property transfer, by Health and Building Department personnel when issuing permits, by public officials in interaction with citizen's groups, and by students in schools interested in natural resource issues.

D. **Nonpoint pollution: Cooperate with and encourage use of the programs administered by the Agricultural Extension Office and other agencies involved in developing Best Management Practices (BMPs).**
Nonpoint pollution is the single largest contributor to groundwater pollution in Clarke County. In Clarke County, it is characterized as pollution from agricultural and residential development practices that cause soil erosion as well as improper fertilizer and pesticide application.

Control measures for agricultural land use are currently supervised by the Natural Resource Conservation Service (NRCS), the Agricultural Stabilization and Conservation Service (ASCS), and the Agricultural Extension Office. These agencies work with farmers to develop Nutrient Resources Plans and implement Best Resources Practices (BMPs), which encourage farmers to avoid highly erodible lands when cropping and maintain minimal levels of fertilizer and pesticide applications. Residential landowners should be educated as to their responsibility for proper fertilizer and pesticide application on lawns and proper septic system maintenance.

E. **Well testing: Establish a Countywide well monitoring network to effectively monitor changes in water quality over time. Including routine testing of specific wells for coliform and water chemistry.**
Well monitoring is a fundamental means of tracking groundwater quality. To date, water testing has been conducted through independent studies where consistency in well monitoring was not required.

F. **Groundwater database development:**

1. **Develop a database of all existing well and septic permits on file in cooperation with the Health Department. Homes with systems not on file should be surveyed to determine the type and location of water source and sewage disposal.**
Identifying the types and locations of well and septic systems in the County is a critical piece of the puzzle with regards to groundwater contamination. Septic systems are a known contamination source. Failing systems or inadequate systems represent the most serious threat. Wells, in addition to being the source of drinking water, also represent pathways for contaminants to enter the groundwater. The Health Department maintains a filing system of all permits issued for well and septic systems in the County. In addition, all systems have been located on a set of County Tax Maps.

2. **Compile existing data from all previously conducted groundwater studies.**
The following agencies and studies have researched aspects of the County's groundwater quality.
    a) Groundwater Hydrogeology and Quality in the Valley and Ridge and Blue Ridge Physiographic Provinces of Clarke County Virginia, by Winfield Wright, 1990. U. S. Geological Survey Water Investigations Report 90-4134.

b) The Influence of Geology and Agriculture on Groundwater Quality in Clarke and Frederick Counties, Virginia, by Richard Peter LoCastro. 1988. Masters Thesis, University of Virginia.
c) EPA STORET
d) Clarke County Health Department water testing: nitrate and coliform sampling
e) U. S. Geological Survey
f) Evaluation of Household Water Quality in Clarke County, Virginia, by Blake Ross et. al. 1992. Agricultural Extension Service 1991 Well Water Survey

Analyzing these data in total can provide the County with valuable insight into trends relating to groundwater contamination.

3. **Use the GIS to identify and map areas sensitive to groundwater contamination. Utilize this information to prioritize areas in need of increased protection measures.**
The GIS is a tool that can best serve County officials by identifying and mapping areas sensitive to groundwater contamination. In addition, tabular data collected in well testing programs can be mapped and analyzed to attempt to identify patterns or correlate pollution problems with soils types or geologic features.

VII. Summary

The residents of Clarke County are proud of their community, its rural character, open space, and scenic beauty. Clean water is a reflection of the overall health of the County's natural environment, and therefore the ability to maintain and enhance the quality of our groundwater is integral to our quality of life. Three-fourths of the people in Clarke County depend on groundwater as the source of their drinking water. Protecting the groundwater from contamination, and thereby protecting public health, has been of primary importance in the County for many years. Human land use activities represent the most serious threat to our water resources.

Land use regulation is the primary means by which to control groundwater contamination. The recommendations detailed in this plan will serve to direct development to areas that are best equipped to assimilate it. Development will be avoided, or preventive measures taken, in areas where a high potential for groundwater contamination exists. These include areas near springs, wells, streams, and sinkholes.

The Groundwater Resources Plan section of the Clarke County Comprehensive Plan is designed to establish a land use planning strategy that will allow land use practices which enhance and protect groundwater quality in the County.

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Summary of the Amendments Adopted to Protect Groundwater Resources in Clarke County.

Septic Ordinance
Adopted December 15, 1987

Amendments

10/18/88	disallow use of alternative septic systems
11/22/88	provide variance procedure reviewed by the Board of Supervisors
12/20/88	add general intent, require soils to be evaluated by a certified soil scientist, add setbacks to springs, strengthen siting requirements
12/17/91	extend variance process to include parcels containing failed wastewater systems constructed after December 15, 1987 (TA-91-09)
02/18/92	establish severability clause and an administrative appeals process (TA-92-06)
03/17/92	allow off-site easements for drainfields for commercial uses (TA-92-01)
12/15/92	(1) establish a variance process; and (2) add the definition of a standard and alternative septic system (TA-92-18)
04/20/93	(1) move the section prohibiting septic systems in the floodway (10 year floodplain) from the Zoning Ordinance to the Septic Ordinance (TA-93-01); and (2) amend the variance section to allow alternative septic systems in limited circumstances and waive public hearing notice and fee requirements for failed systems requiring emergency repairs (TA-93-08)
07/20/93	add well variances to responsibilities of the Board of Septic and Well Appeals (TA-93-13)
12/21/93	amend variance criteria for historic properties to require application for historic overlay district (TA-93-15)
01/18/94	prohibit all new pit privies except portable for temporary activities, or vault privies outside the 10 year floodway, for primitive recreational areas with intermittent use and no plumbing facilities. (TA-93-15)
02/15/94	require removal of nonportable pit privies in the 10 year floodway of the Shenandoah River by May 1, 1995 (TA-93-15)
02/21/95	100% reserve area requirement, clarify and simplify ordinance, and strengthen system siting requirements. (TA-94-08a)
12/19/95	amend definition of standard subsurface septic system to include Perc-Rite drip disposal systems (TA-95-10)
06/20/95	add septic system maintenance section requiring pump-out of septic tanks, cesspools, and dry wells (TA-95-06)

04/21/98 establish procedure to consider a variance when a 100% reserve drainfield cannot be provided for an existing house (TA-98-02)

Well Ordinance
Adopted March 20, 1990
Implemented May 1, 1991

Amendments

11/17/92 eliminate water testing requirement at time of issuance of building permit and establish new sampling procedure prior to issuance of Health Department approval (TA-92-17)

07/20/93 add administrative appeals process and severability clause and establish criteria for well variances (TA-93-13)

12/21/93 add variance section requiring historic homes receiving variances to apply for historic overlay designation (TA-93-15)

10/18/94 clarify and simplify ordinance; add section prohibiting encroachment on an existing well in a manner that decreases conformance to setbacks from pollution sources (TA-94-08)

Sinkhole Ordinance
Adopted January 20, 1987

Zoning Ordinance
Natural Resource Conservation Overlay District
Adopted July 20, 1983

Amendments

03/20/90 enlarge maximum lot size from 2 to 4 acres (TA-90-03)

06/15/93 strengthen requirements for installation of on-site septic systems (TA-93-02)

01/20/98 prohibit construction within 400 feet of Prospect Hill Spring except for public utilities (TA-97-09)

Subdivision Ordinance
Amendments (as related to septic systems and wells)

05-18-93 delete requirement for siting septic drainfields on large tracts (41-100 acres) (TA-93-06)

12-19-95 require surveyed location of on-site septic systems on plats (TA-95-11)

02/17/98 require a reserve drainfield area for proposed parcels containing existing houses (TA-98-01)

APPENDIX B

CLARKE COUNTY HEALTH DEPARTMENT
P. O. BOX 327
21 SOUTH CHURCH STREET
BERRYVILLE, VIRGINIA 22611
(703) 955-1033 FAX (703) 743-3811

Comparison of the Commonwealth of Virginia State Board of Health Sewage Handling and Disposal Regulations and the County of Clarke Standards and Procedures for the Siting and Installation of Subsurface Septic Systems

Unsatisfactory percolation rate: the State regs utilize a sliding scale based on the percolation rate of the soil in minutes per inch (enclosed is the table which delineates these minimum separation distances to seasonal water table); the County requires a 20-inch separation distance to the seasonal water table regardless of percolation rate of the soil.

Bedrock: the State requires a 12-inch separation distance (horizontally and vertically) from trench bottom to bedrock; the County requires 24 inches (horizontally and vertically) from bedrock and 10 feet horizontally from surface rock outcrops.

Fragipans: the State requires a 12-inch separation distance (horizontally and vertically) from trench bottom to a pan; the County requires a 20-inch separation distance from trench bottom to a pan.

Coarse fragments: the State allows up to 75 percent of the horizon to be made up of rock and rock fragments before it considers it rock and requires the 12-inch stand-off; the County only allows 50 percent of the horizon to be rock or rock fragments and then it requires a 24-inch stand-off.

Percolation test procedures: the County has expanded on the basic requirements of the State when high shrink-swell soils are suspected. These measures are to further ensure that these soils are thoroughly wetted and swollen before the actual water percolation tests are performed. If this type of soil is not fully wetted, it could pass the test with an acceptable rate.

Slope: the State prohibits systems on slopes of greater than 50 percent unless terraced; the County prohibits systems on slopes greater than 25 percent.

Free-flowing streams, bodies of water: the State maintains a basic setback of 50 feet; the County 100 feet.

Intermittent streams, drainageways: the State maintains a range of setbacks (10 to 70 feet)* depending on characteristics of the drainage ditch; the County requires a 50 foot setback from the lowest point of the drainage.

Wells, sinkholes, cave entrances: the State requires 50 feet from Class IIIB wells (only drinking water wells permitted in Clarke), 100 feet from the low point of the sinkhole, and they do not address cave entrances from my knowledge; the County requires 100 feet from wells and 100 feet from the discernible edge of sinkholes and caves.

Springs: the State requires basically a 200 foot setback from a development spring; the County requires a setback of 500 feet if drainfield is above spring in elevation and 200 feet if drainfield is below spring in elevation.

Easements: the State allows drainfield easements; the County prohibits easements for drainfield installation.

Dosing systems: the County has addressed the use of pumps for septic systems in soils with either very high or very low perc rates; the State does not necessarily require them in soils with those rates, however, they may be utilized.

Consultants: the State does not require any registration or certification of soil consultants; the County requires the consultants to apply and be approved (based on education and experience) to work in this county. The Clarke County Health Department accepts only soil work signed by a county-approved consultant.

* See Table 4.4 (enclosed) for explanation about drainage ditches.

groundwater table, as indicated by free water, is at its lowest level. Acceptable separation distances to free standing groundwater shall be as follows:

Minimum Separation Distances to Seasonal Water Table

Percolation Rate Minutes / Inch	Distance from Trench Bottom Inches
5	2
17	3
46	12
90	18
120	20

c. because of the increased risk of failure, a conditional permit shall not be issued, in an area with a seasonally fluctuating water table if the proposed absorption area is within 200 feet of a shellfish growing area, recreational waters or a public water supply impoundment.

5. The district or local health department shall affix to the conditional construction permit a clear and concise statement relating the conditions and circumstances which formed the basis for issuing the conditional permit as well as the owner's obligations under the permit.

RECORDED DEED

6. The holder of any conditional construction permit shall have the permit recorded and indexed in the grantee index under the holder's name in the land records of the clerk of the circuit court having jurisdiction over the site of the septic tank system. District or local health departments shall be provided with certification that the conditional septic tank system permit has been recorded in the land records of the circuit court. The conditional permit shall become effective one day after the district or local health department receives notification of recordation. The district or local health department shall advise the local building official that conditional septic tank system permits are not valid without certification that the permits have been properly recorded as required and shall forthwith notify the local building official when the conditional permit becomes effective. Final approval of the construction of the septic tank subsurface soil absorption system shall not be given until or unless the system is constructed in accordance with the conditions of the permit. The operation permit will be issued in accordance with § 2.22.

7. As per § 32.1-164.1 of the Code of Virginia, the holder of the permit and any subsequent holders of the permit shall be bound by the conditions stated in the permit unless the holder or subsequent holder obtains an additional permit for modification or alteration of the septic tank system to meet any new use conditions.

§ 2.14 Requirements for the submission of formal plans, specifications and other data.

A. In accordance with the provisions of the Code of Virginia, §§ 54-17.1 through 54-41 all formal drawings, specifications, reports, and other documents submitted for approval shall be prepared by or under the supervision of a licensed professional engineer. The front cover of each set of drawings, of each copy of data and each copy of the specifications submitted shall bear the original imprint of the seal and signature of the licensed professional engineer by or under whom prepared. In addition each drawing submitted shall bear an imprint or a legible facsimile of such seal.

Minimum Separation Distances

Structure or Topographic Features	Soil Texture Group	Minimum Distance (Ft) From Bottom or Sidewall Of Subsurface Soil Absorption System Trench		
		Vertical	Horizontal	
Property Lines	I, II, III, IV	—	5	
Building Foundations	I, II, III, IV	—	10	
Basements	I, II, III, IV	—	20	
Drinking Water Wells				
Class I & II = IIIA, IIIB	I, II, III, IV	—	50	
Class ~~III~~ – IIIC	I, II, III, IV	—	100	
Cisterns (Bottom Elevation Lower Than Ground Surface in Area of Subsurface Soil Absorption System)	I, II, III, IV	—	100	
Shellfish Waters	I, II, III, IV	—	70	
Natural Lakes & Impounded Waters	I, II, III, IV	—	50	
Streams	I, II, III, IV	—	50[a]	
Development Springs (Up Slope)	I, II, III, IV	—	200[e]	
Rock, Rock Outcropping, Pans and Impervious Strata	I	1	1	
	II	1	1	
	III	1	1	
	IV	1	1	
Drainage Ditches				
Ditch Bottoms Above Seasonal Water Table	I, II, III, IV	—	10	
Ditch Bottom Below Seasonal Water Table and Ditch Normally Contains Water	I	—	70[a]	
	II	—	70[a]	
	III	—	50[a]	
	IV	—	50[a]	
Water Table Depressor System	I	6[b]	70	
	II	3[b]	70	
	III	2[b]	50	
	IV	2	50	
Lateral Groundwater Movement Interceptor	I	—	70[c]	10[d]
	II	—	70[c]	10[d]
	III	—	50[c]	10[d]
	IV	—	50[c]	10[d]
Low Point of Sink Holes When Placed Within The Bowl Of The Sink Hole	I, II, III, IV	—	100	
Utility Lines	I, II, III, IV	—	10	

[a] The set back distance may be reduced to 10 feet in Group III and IV soils and 20 feet in Group I and II soils if the subsurface soil absorption system is designed to produce unsaturated flow condition in the soil.

[b] Vertical distance to the invert of the drain tile in the water table depressor system

[c] Absorption trench up slope from interceptor

[d] Absorption trench down slope from interceptor

[e] Arc of 180 degree up slope of spring and 100 ft. down slope

ll Regulations - State versus Clarke Count (see footnote)

Parameter	State		Clarke County
Class I well	no definition		cased and grouted to solid rock minimum casing and grout of 100 feet
Class IIIA	annular space around casing is grouted to min. 20 feet (1) well drilled and cased to at least 100 feet (2) cased drill hole shall pass through min. of 50 feet of collapsing material		cased to solid rock minimum casing 100 feet minimum grout 20 feet only when rock formation precludes grouting to 50 fee
Class IIIB	cased and grouted to a minimum depth of 50 feet		cased and grouted to minimum depth of 50 feet
Distances between Well and Contamination Source	Class IIIA	ClassIIIB	All new water supplies
Chemical Storage Tank	100	50	100
Feedlots, hog lots, poultry houses	100	50	100
Petroleum Storage tanks	100	50	100
Road surface (public)	N/A		25
Septic Tanks	50	50	100
Absorption field	100	50	100
Cesspools, pit privies, etc.	100	50	150
Intermittent Streams	18" above annual flood level		50
er sewers	50	50	50
ennial Streams	18" above annual flood level		100
Property lines	no separation distance		10
Foundation of buildings of solid masonry	10	10	50
Foundation of buildings of wood framing			100
or exterior	10	10	50
Sinkholes and cave entrances	no separation distance		100
Termite treated foundations	50	50	100
Cemetery	100	50	100

Note: This table represents a general summary only,
refer to specific State and County Regulations for complete detail on separation distance requirements

12VAC5-630-380. Well location.

A. Sanitary survey. Any obvious source of toxic or dangerous substances within 200 feet of the proposed private well shall be investigated as part of the sanitary survey by the district or local health department. Sources of contamination may include, but are not limited to, items listed in Table 3.1, abandoned wells, pesticide treated soils, underground storage tanks, and other sources of physical, chemical or biological contamination. If the source of contamination could affect the well adversely, and preventive measures are not available to protect the ground water, the well shall be prohibited. The minimum separation distance between a private well and structures, topographic features, or sources of pollution shall comply with the minimum distances shown in Table 3.1. Where the minimum separation distances for a Class IV well cannot be met, a permit may be issued under this chapter for a well meeting all of the criteria in 12VAC5-630-400 and 12VAC5-630-410 and the separation distance requirements for either a Class IIIA or IIIB well, without deviation, and such Class IV well shall not be required to meet the water quality requirements of 12VAC5- 630-370.

TABLE 3.1 DISTANCES (IN FEET) BETWEEN A WELL AND A STRUCTURE OR TOPOGRAPHIC FEATURE

Structure or Class III Class III Topographic Feature C or IV	A	B
Building Foundation	10	10
Building Foundation (Termite Treated) House	50[1]	50[1]
Sewer Line	50[2]	50[2]
Sewer Main Including force mains	50[3]	50[3]
Sewerage System	50	50
Pretreatment System (e.g. Septic Tank, Aerobic Unit, etc.)	50	50
Sewage Disposal System or other contaminant source (e.g., drainfield underground storage tank, barnyard, hog lot, etc.)	100	50
Cemetery	100	50
Sewage Dump Station	100	50[1]

FN1 See 12VAC5-630-380.

FN2 Private wells shall not be constructed within 50 feet of a house sewer line except as provided below. Where special construction and pipe materials are used in a house sewer line to provide adequate protection, and the well is cased and grouted to the water bearing formation, all classes of private wells may be placed as close as 10 feet to the house sewer line. Special construction for house sewer lines constitutes cast iron pipe with water-tight caulked joints or mechanical joints using neoprene gaskets, or solvent welded Schedule 40 or better polyvinyl chloride (PVC) pipe. It is the responsibility of the applicant to provide documentation from the contractor that such construction and pipe materials have been installed. In no case shall a private well be placed within 10 feet of a house sewer line.

FN3 Private wells shall not be constructed within 50 feet of a sewer main except as provided below. Where special construction and pipe materials are used in a sewer main to provide adequate protection, and the well is cased and grouted to the water bearing formation, Class III wells may be placed as close as 35 feet to a sewer main and Class IV wells as close as 10 feet. Special construction for sewer mains constitutes ductile iron pipe with water-tight joints, solvent welded Schedule 40 or better polyvinyl chloride (PVC) pipe (SDR-35 plastic PVC with neoprene gaskets). It is the responsibility of the applicant to provide documentation from the local building official or sanitary district that such construction and pipe materials have been installed. In no case shall a Class III well be place within 35 feet of a sewer main. Likewise, in no case shall a Class IV well be placed within 10 feet of a sewer main.

B. Downslope siting of wells from potential sources of pollution. Special precaution shall be taken when locating a well within a 60 degree arc directly downslope from any part of any existing or intended onsite sewage disposal system or other known source of pollution, including, but not limited to, buildings subject to termite or vermin treatment, or used to store polluting substances or storage tanks or storage areas for petroleum products or other deleterious substances. The minimum separation distance shall be: (i) increased by 25 feet for every 5.0% of slope; or (ii) an increase shall be made to the minimum depth of grout and casing in the amount of five feet for every 5.0% of slope.

C. Sites in swampy areas, low areas, or areas subject to flooding. No private well covered by this chapter shall be located in areas subject to the collection of pollutants such as swampy areas, low areas, or areas subject to flooding. Wells located in flood plains shall be adequately constructed so as to preclude the entrance of surface water during flood conditions. At a minimum, such construction will include extending the well terminus 18 inches above the annual flood level. Other requirements may be made as determined on a case by case basis by the division.

D. Property lines. There is no minimum separation distance between a private well and a property line established by this chapter. The owner is responsible for establishing a separation distance from property lines such that the construction and location of the well will be on the owner's property and comply with any local ordinances.

E. Utility lines. There is no minimum separation distance between a private well and utility lines (electric, gas, water, cable, etc.). The minimum separation distance may, however, be established by the individual utility company or local ordinance.

F. Pesticide and termite treatment. No Class III private well shall be placed closer than 50 feet from a building foundation that has been chemically treated with any termiticide or other pesticide. No Class IV private well shall be placed closer than 50 feet to a building foundation that has been chemically treated with any termiticide or other pesticide except as provided below. Further, no termiticides or other pesticides shall be applied within five feet of an open water supply trench. A Class IV well may be placed as close as 10 feet to a chemically treated foundation if the following criteria are met:

1. The aquifer from which the water is withdrawn must be a confined aquifer (i.e., there must be an impermeable stratum overlying the water bearing formation).

2. The well must be cased and grouted a minimum of 20 feet or into the first confining layer between the ground surface and the water bearing formation from which water is withdrawn, whichever is greater. When the first confining layer is encountered at a depth greater than 20 feet, the well shall be cased and grouted to the first confining layer between the ground surface and the water bearing formation from which water is withdrawn.

3. The material overlaying the confined aquifer must be collapsing material.

G. Exception for closed-loop ground-source heat pump wells. Closed-loop ground-source heat pump wells, depending upon construction, may not have to comply with the minimum separation distances for Class IV wells listed in Table 3.1. If the well is grouted 20 feet, the minimum separation distances must comply with those listed for Class IV wells. If the well is grouted a minimum of 50 feet, the separation distances shall be those listed for Class IIIA or IIIB wells. If the well is grouted the entire depth of the well, the well does not have to comply with the minimum separation distances contained in Table 3.1.

Statutory Authority

§§32.1-12 and 32.1-176 of the Code of Virginia.

Historical Notes

Derived from VR355-34-100 §3.4; eff. April 1, 1992.

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SURFACE WATER RESOURCES PLAN

Adopted

December 7, 1999

Clarke County
Comprehensive Plan
Implementing Component
Article 5b

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Executive Summary: Surface Water Resources Plan

The Surface Water Resources Plan is one of two sections of the Water Resources Plan, an implementing component of the Clarke County Comprehensive Plan. This section specifically addresses issues relating to surface water, including surface water contamination from both point and nonpoint sources, off stream water use such as domestic supply and irrigation, and recreational uses.

Efforts to improve surface water quality throughout the region have been driven by the regional need to improve water quality in the Chesapeake Bay. Water quality degradation caused by nutrient over enrichment has played a key role in the decline of the living resources of the Chesapeake Bay and its tributaries. The need to reduce the nutrient flow from tributaries into the Chesapeake Bay prompted states, including Virginia, to enter into the Chesapeake Bay Agreement in 1987. This agreement contains a commitment to reduce the controllable loads of phosphorus and nitrogen entering the Bay by 40% by the year 2000. The Shenandoah/Potomac River Basins Nutrient Reduction Strategy was developed as a result of this commitment. The strategy outlines programs and provides increased funding opportunities to localities to improve water quality on a voluntary basis. As an implementing component of the Comprehensive Plan, the Surface Water Resources Plan reflects Clarke County's desire to participate in the regional cleanup process as well as protect our natural resources for our own benefit. This is clearly stated in Objective 3: "Protect natural resources, including soil, water, air, scenery, and fragile ecosystems."

The Virginia Department of Conservation and Recreation Division of Soil and Water Conservation (DCR-DSWC) and the Department of Environmental Quality (DEQ) are responsible for monitoring, assessing, and compiling data collected about State waterways. Members of Friends of the Shenandoah River (FOSR) collect additional water chemistry data.

Known Contamination Problems

Nutrients, specifically nitrates and phosphorus, are being discharged into waterways by sewage treatment facilities, ultimately degrading the water quality of the Chesapeake Bay. In areas where livestock have unlimited access to tributaries and there is septic system failure, coliform contamination is occurring. At present, the major impact of fecal pollution in Clarke County is the degradation of recreational water quality in both the streams and the Shenandoah River. This pollution reduces the quality of recreational pursuits and represents a health risk for all types of water-contact activities. In addition, reducing the fecal loading in surface waters is a critical step in protecting ground and drinking waters. Contaminated surface waters have been shown to degrade groundwater quality, which in turn will degrade well water. Contamination from point and nonpoint sources has been identified in three waterways and is likely in many others.

DEQ has evaluated Spout Run, Opequon Creek, and the Shenandoah River. Spout Run has been listed as an impaired waterway due to high fecal coliform bacteria counts. The impairment source is listed as nonpoint source (NPS)-agriculture, based on the assessment by DCR of this waterbody's having a high potential for nonpoint source pollution from agricultural lands. Although listed as nonpoint agriculture, source differentiation tests were not conducted. Preliminary sampling by the County has identified human sources below Millwood and contamination from failing or inadequate sewage disposal in Millwood as a probable source for this contamination. The Opequon Creek impairment is designated as a moderately impaired benthic community, attributed by DCR to nonpoint source urban runoff. The Shenandoah River impairment cause is listed as PCBs generated from the former Avtex Fibers Plant in Front Royal. The Virginia Department of Health has issued a Health Advisory, recommending that fish from the river not be consumed.

Streams Susceptible to Contamination

DCR-DSWC prepared the 1997 Virginia Nonpoint Pollution Assessment Report, which provides a comparative evaluation of State waters on a watershed basis, to assist in targeting nonpoint source (NPS) pollution minimization activities and resources. The report was developed from two types of data: inventory and water quality monitoring. The inventory data consist of livestock inventories, land use, and soil erosion rates and were collected and compiled by DCR to address the NPS potential from three major land use categories: agricultural, urban, and forestry. DCR evaluates the susceptibility to surface water contamination for all streams on a watershed basis and gives each a priority ranking. Of the two watersheds completely within Clarke County, which encompass 72% of the land area, the report identified Spout Run (40%) as a high priority, and the Lower Shenandoah (32%) as a low priority. Actual contamination levels within these watersheds can be determined only by water sampling.

Water Quality Improvement Activities

Providing for and maintaining riparian buffers, in conjunction with reducing or eliminating contamination sources, are the most effective ways to improve surface water quality in Clarke County. The Virginia Agricultural Best Management Practices (BMP) Cost-Share Program encourages the voluntary use of agricultural BMPs to improve water quality by reducing the transport of pollutants such as sediments and nutrients from the land to our waters. Between 1989 and 1997, 34 farms participated in the Cost-Share Program, creating a total of 1,900 acres of riparian buffer. This action has resulted in a reduction of 29,964 pounds of nitrates and 4,540 pounds of phosphorus from reaching the waterways of Clarke County. With the increase in funding levels over the last two years, approximately 20 additional farms will begin installing a variety of BMPs designed to improve water quality. This level of participation provides a clear indication that the farming community is interested in protecting the natural environment.

The Page Brook Watershed Restoration Project was initiated in 1996, with receipt of a $75,000 EPA Section 319 grant to conduct a watershed study examining practical approaches of BMP installation to improve water quality. Approximately 2.5 miles of fencing were installed on four farms in the watershed. The effectiveness of the BMP installation was determined by analyzing water samples collected monthly throughout the project. Within one year, fecal coliform bacteria counts collected at sites within fenced buffer areas were reduced by an average of 92%. Initially, coliform bacteria counts were at levels high enough to declare the stream impaired, but since fencing and other BMPs have been installed, coliform levels have been reduced below the impairment level.

Implementation Steps

Eleven actions are recommended in this Plan in order to protect the County's surface water resources. They are, in order of priority:

1. Establish a Stream Protection Overlay District and adopt regulations to protect designated areas.

2. Amend the Zoning Ordinance to require 100 foot building setbacks from perennial streams and springs, and 50 foot building setbacks from intermittent streams, as identified on the 7.5 minute USGS topographical maps, in the Agricultural-Open Space (AOC) District.

3. Establish a Countywide surface water monitoring network to effectively monitor changes in water quality over time. This program would include routine testing of and official reporting for all perennial streams for coliform and water chemistry.

4. Encourage upgrading of sewage treatment plants to reduce nutrient discharge into surface waters.

5. Encourage installation of Best Management Practices (BMPs) to reduce access of livestock to riparian buffer zones.

6. Identify locations of individual onsite sewage disposal systems discharging into State waterways and replace them with conventional septic systems where possible.

7. Consider adopting a Shenandoah River Recreation Plan.

8. Increase funding to multijuridictional Minimum Instream Flow study so that the data necessary to declare a Surface Water Management Area are available as soon as possible.

9. Conduct a comprehensive study in cooperation with the USGS to fully characterize tributary stream flow patterns, discharge rates, and floodplains.

10. Update the 1988 Water Supply Plan to ensure that adequate water resources are available for Clarke County residents.

11. Conduct additional dye tracing studies to increase understanding of the interrelationship between ground and surface waters in the County.

I. Introduction

The residents of Clarke County are proud of their community- its rural character, open space, and scenic beauty. The rivers and streams enhance that beauty and are significant resources for many reasons. The Shenandoah River is the largest surface water feature in the County. It is a designated State Scenic River and is a major recreational attraction. Opequon Creek also offers a variety of recreational opportunities. Smaller tributaries provide water for livestock, and a few are large enough for swimming and fishing. A clean and adequate water supply is a reflection of the overall health of the County's natural environment, and maintaining the quality of our water resources is integral to our quality of life.

But there are problems with the County's waters. Nutrients, specifically nitrates and phosphorus are being discharged into waterways by sewage treatment facilities, ultimately degrading the water quality of the Chesapeake Bay. In areas where livestock have unlimited access to tributaries, coliform contamination is occurring. At present, the major impact of fecal pollution is the degradation of recreational water quality in both the streams and the Shenandoah River. This pollution reduces the quality of recreational pursuits and represents a health risk for all types of water contact activities. In addition, reducing the fecal loading in surface waters is a critical step in protecting ground and drinking waters (Hagedorn 1999). Contaminated surface waters have been shown to degrade groundwater quality, which in turn will degrade well water (Bickie and Brown 1991, Ritter and Chirnside 1984; Townsend et. al., 1996; Gold et. al. 1990; Cook et. al. 1996; Howell 1995; Tornley 1985). Contamination from point and nonpoint sources has been identified in three waterways and is likely in many others.

Efforts to improve surface water qualities throughout the region have been driven by the regional need to improve water quality in the Chesapeake Bay. Water quality degradation caused by nutrient over enrichment has played a key role in the decline of the living resources of the Chesapeake Bay and its tributaries. The need to reduce the nutrient flow from tributaries into the Chesapeake Bay prompted states, including Virginia, to enter into the Chesapeake Bay Agreement in 1987. This agreement contains a commitment to reduce the controllable loads of phosphorus and nitrogen entering the Bay by 40% by the year 2000. The Shenandoah/Potomac River Basins Nutrient Reduction Strategy was developed as a result of this commitment. This strategy outlines programs and provides increased funding opportunities to localities to improve water quality, but makes it clear that Virginia prefers a voluntary, cooperative approach to implement the program. Therefore, to reducing nutrient loads and participating in the Bay cleanup is a local decision (Commonwealth of Virginia 1996).

The primary threats to water quality within Clarke County come from point source discharge of sewage treatment facilities and nonpoint agricultural and urban runoff. The agricultural community has demonstrated its commitment to protecting the land and water quality in many ways. Between 1989 and 1997, 34 farms participated in the Cost-Share Program, creating a total of 1,900 acres of riparian buffer. The Virginia Agricultural Best Management Practices Cost-Share Program encourages the voluntary use of agricultural BMPs to improve water quality by reducing the transport of pollutants such as sediments and nutrients from the land to our waters. The program is funded with State and Federal monies through local soil and water conservation districts. Practices eligible for cost sharing include animal waste-control facilities, sod waterways, stream protection, winter cover crops, buffer strip cropping, and terracing, among others (Commonwealth of Virginia 1996). With the increase in funding levels over the last two years, approximately 20 additional farms will begin installing a variety of BMPs, including stream fencing, riparian plantings, and off-site watering, designed to improve water quality. Agriculture is an integral part of the historic and economic makeup of the County and is valued as a principal land use. Efforts to reduce surface water contamination from agricultural nonpoint sources must be carefully considered to minimize any possible negative impact on the agricultural community.

Historically, surface water management in Clarke County has been overshadowed by groundwater management activities. Groundwater protection has been emphasized, as 75% of County residents rely on groundwater as their source for drinking water, and groundwater is particularly susceptible to contamination. This is especially true in the Valley region of the County, the geologic region located west of the Shenandoah River. Carbonate rocks such as limestone and gypsum underlie this region. This type of geology is characterized by the presence of solution-enlarged sinkholes, conduits, and caves, geologic features that constitute what is known as karst terrane. The generally high permeability of these rocks facilitates the infiltration and transport of contaminants from the land surface to the groundwater reservoir. This interaction became particularly evident in 1994, when the State Health Department declared Prospect Hill Spring under the influence of surface water, mandating the construction of a disinfection and filtration system. Prospect Hill Spring is the only public water supply administered by the County it serves 300 households and businesses in the communities of Boyce, Millwood, the Waterloo Commercial District, and White Post. The high degree of interaction between ground and surface waters is an important reason to increase efforts to improve surface water quality.

The Surface Water Resources Plan section of the Clarke County Comprehensive Plan is designed to provide a planning strategy that will allow for adequate surface water quality and quantity for County residents in the future.

II. Purpose and Scope

The purpose of the plan is to protect and improve surface waters throughout the County by minimizing the adverse impacts of human land use activities. Benefits of having clean surface waters include the protection of public water supplies, groundwater protection, safe water based recreation, and decreased nutrient enrichment of the Chesapeake Bay.

As an implementing component of the Clarke County Comprehensive Plan (1994), the Surface Water Resources Plan reflects the County's desire to participate in the regional cleanup process, as well as protect our natural resources for our own benefit. This is clearly stated in Objective 3: "Protect natural resources, including soil, water, air, scenery, and fragile ecosystems." Policies outlined under Objective 3 include: (1) prohibiting land uses that have significant adverse environmental impacts, recognizing the interrelationship among natural resources, especially between ground and surface waters in karst topography; (2) requiring that adverse environmental impacts of activities directly or indirectly related to new construction, including removal of vegetation, cutting of trees, altering drainageways, grading, and filling, are minimized; (3) strengthening, implementing, and enforcing the Erosion and Sedimentation Control Ordinance; (4) managing and protecting surface water resources; (5) recognizing the Shenandoah River as a

State Scenic River and one of the County's significant environmental resources; and (6) protecting local and regional water resources through application of the Chesapeake Bay Management Regulations to environmentally sensitive areas.

This plan describes the surface water resources in the County and the contamination sources, summarizes the many Federal, State, and local activities that are currently in place, and makes recommendations for future steps to protect and improve surface water quality locally. Through the process of describing the contamination concerns and efforts to mitigate surface water degradation, a specific action plan is developed that compiles all available protection strategies in order to improve and protect surface waters in Clarke County.

III. Description of Resources

Clarke County, located in the northern Shenandoah Valley, is approximately 110,000 acres. The eastern third of the County consists of the western slope of the Blue Ridge Mountains. This region is primarily forested and contains portions of 11 perennial tributaries of the Shenandoah River. Approximately 22 miles of the main stem of the Shenandoah River run through, and divide, the County. The western two-thirds of the County are in the northern Shenandoah Valley and are primarily open land in agricultural use. Portions of 10 perennial streams flow eastward through the Valley to the Shenandoah River. Three tributaries flow into the Opequon Creek drainage that forms the western boundary between Clarke and Frederick County, Virginia (figure 1).

The two regions of the County represent two different hydrogeologic areas- the Valley and Ridge and the Blue Ridge physiographic provinces (figure 2)- each underlain by characteristic bedrock types. Bedrock in the Valley region consists of carbonates (limestones and dolomites) and calcareous shales. In the Blue Ridge region, bedrock consists of metamorphic forms of basalt, sandstone, quartzite, slate, and shale. The rocks of the Blue Ridge are more resistant to weathering and erosion, and this resistance is expressed in the more mountainous terrain, compared to the Valley region (Wright 1990).

A large portion of stream flow is from groundwater, with the remainder from surface runoff during rain events. In studies completed in Shenandoah National Park, flow data were collected from streams in geologic formations similar to those found in Clarke County. Data indicated that yields were lowest for streams draining areas with steep slopes and a shallow overburden (unconsolidated material overlying bedrock, such as loose soil, silt, sand, and gravel), where underlying bedrock is resistant to groundwater infiltration and storage (Lynch 1987). In contrast, Valley streams flow over relatively flat topography and have a thick overburden that acts like a sponge to store water that slowly recharges the groundwater system (Wright 1990). In addition, most Valley streams are spring fed from high yielding springs found in the carbonate aquifer. Springs are less prolific on the mountain. Flows are greater in the valley due to the solution-enlarged fractures and bedding planes. Because these features are larger, they hold more water. Fractures and bedding planes have not been enlarged on the mountain, because the rock is not as soluble. Although these generalities hold true, the actual details of interactions among stream flow patterns, runoff, and spring discharge are not fully understood. To characterize more fully the stream flow patterns, discharge rates, and floodplains, more study is needed.

SURFACE WATER RESOURCES PLAN

Adopted

December 7, 1999

Clarke County
Comprehensive Plan
Implementing Component
Article 5b

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This plan describes the surface water resources in the County and the contamination sources, summarizes the many Federal, State, and local activities that are currently in place, and makes recommendations for future steps to protect and improve surface water quality locally. Through the process of describing the contamination concerns and efforts to mitigate surface water degradation, a specific action plan is developed that compiles all available protection strategies in order to improve and protect surface waters in Clarke County.

III. Description of Resources

Clarke County, located in the northern Shenandoah Valley, is approximately 110,000 acres. The eastern third of the County consists of the western slope of the Blue Ridge Mountains. This region is primarily forested and contains portions of 11 perennial tributaries of the Shenandoah River. Approximately 22 miles of the main stem of the Shenandoah River run through, and divide, the County. The western two-thirds of the County are in the northern Shenandoah Valley and are primarily open land in agricultural use. Portions of 10 perennial streams flow eastward through the Valley to the Shenandoah River. Three tributaries flow into the Opequon Creek drainage that forms the western boundary between Clarke and Frederick County, Virginia (figure 1).

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A large portion of stream flow is from groundwater, with the remainder from surface runoff during rain events. In studies completed in Shenandoah National Park, flow data were collected from streams in geologic formations similar to those found in Clarke County. Data indicated that yields were lowest for streams draining areas with steep slopes and a shallow overburden (unconsolidated material overlying bedrock, such as loose soil, silt, sand, and gravel), where underlying bedrock is resistant to groundwater infiltration and storage (Lynch 1987). In contrast, Valley streams flow over relatively flat topography and have a thick overburden that acts like a sponge to store water that slowly recharges the groundwater system (Wright 1990). In addition, most Valley streams are spring fed from high yielding springs found in the carbonate aquifer. Springs are less prolific on the mountain. Flows are greater in the valley due to the solution-enlarged fractures and bedding planes. Because these features are larger, they hold more water. Fractures and bedding planes have not been enlarged on the mountain, because the rock is not as soluble. Although these generalities hold true, the actual details of interactions among stream flow patterns, runoff, and spring discharge are not fully understood. To characterize more fully the stream flow patterns, discharge rates, and floodplains, more study is needed.

Figure 1

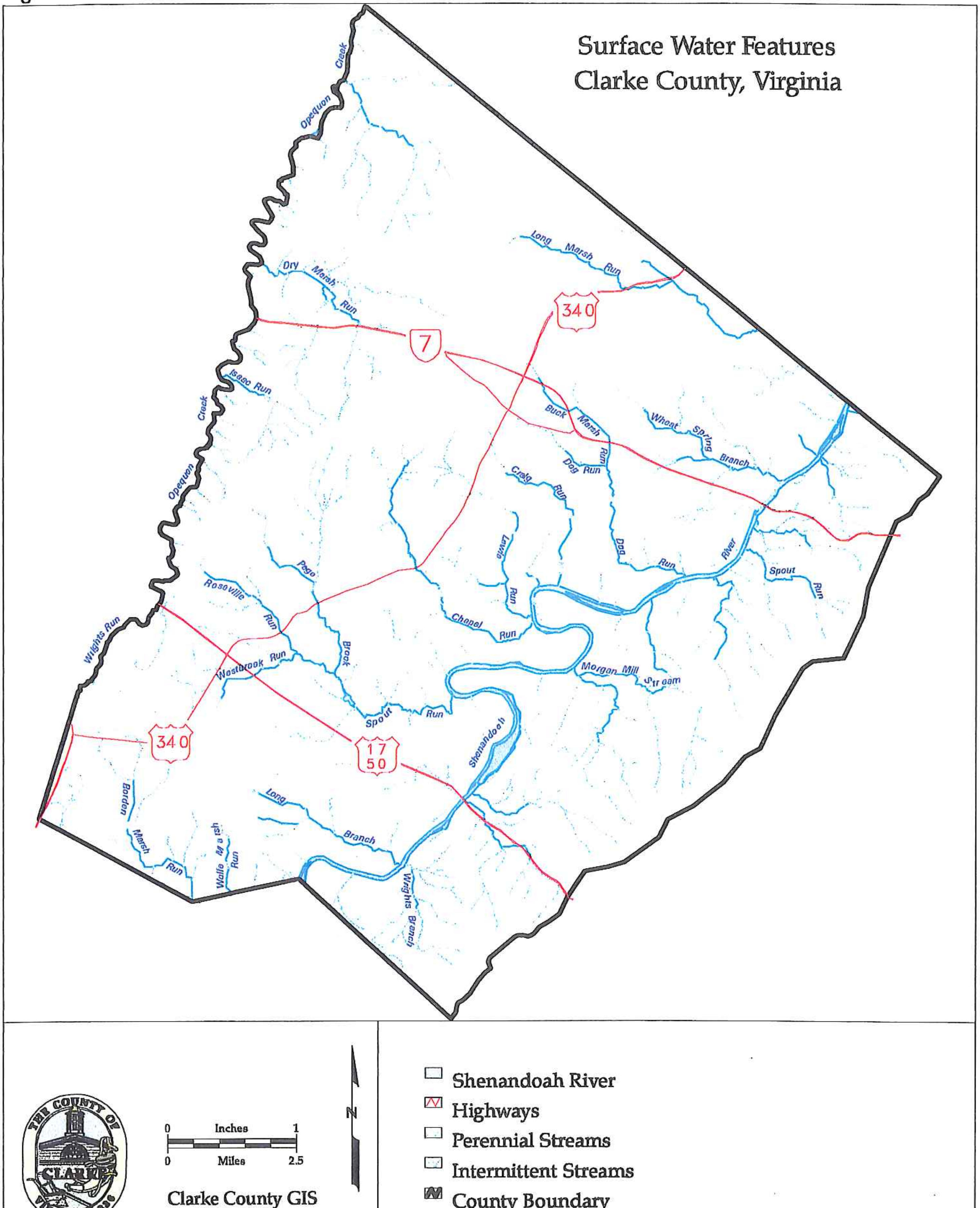
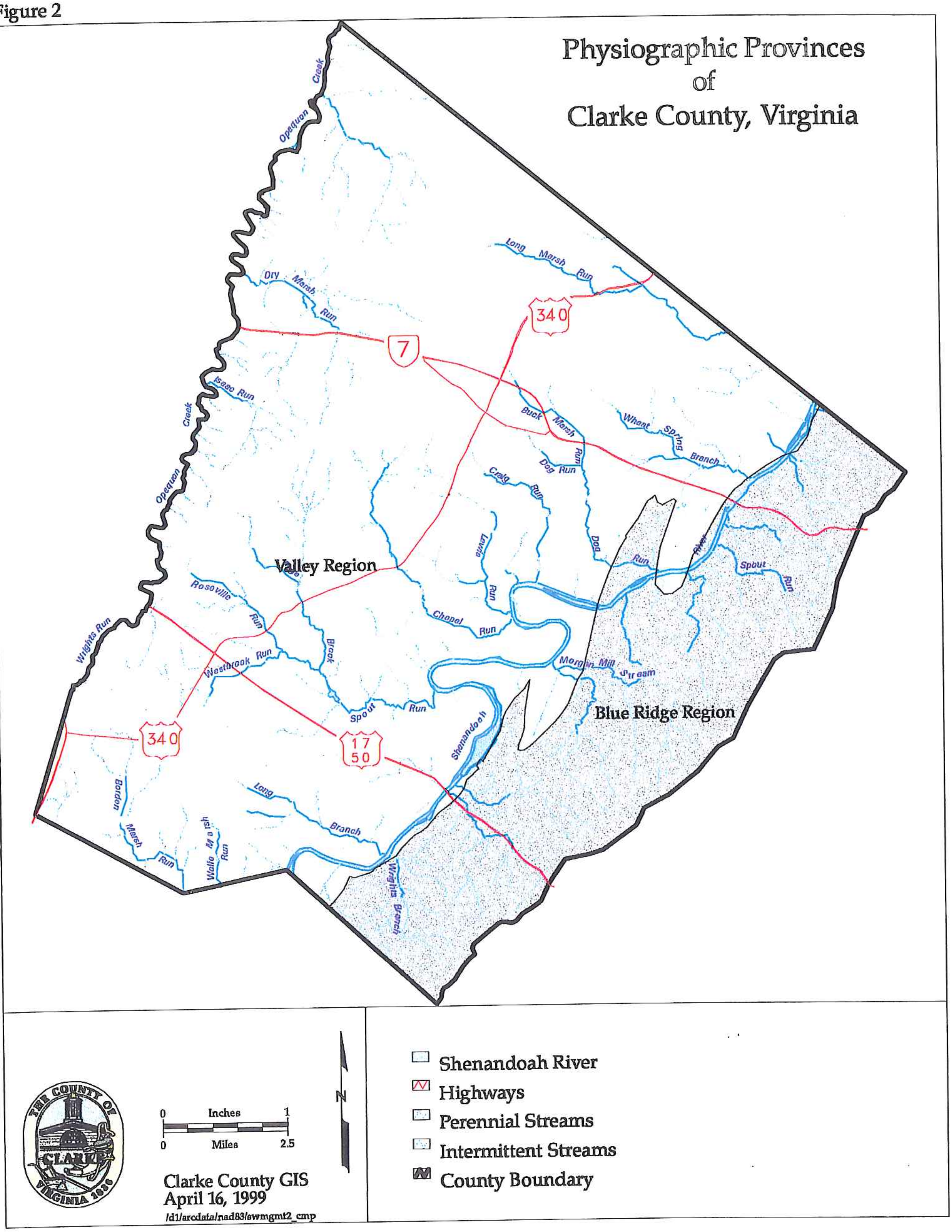

Surface Water Features
Clarke County, Virginia
Opequon Creek
Long Marsh Run
Dry Marsh Run
340
7
Isaac Run
Buck Marsh Run
Wheat Spring Branch
Dog Run
Craig Run
Lewis Run
Dog Run
River
Spout Run
Page Brook
Roseville Run
Chapel Run
Wrights Run
Westbrook Run
Morgan Mill Stream
Spout Run
340
17
50
Shenandoah
Long Branch
Borden Marsh Run
Wolfe Marsh Run
Wrights Branch
0 Inches 1
0 Miles 2.5
N
Clarke County GIS
April 16, 1999
/d1/arcdata/nad83/swmgmt1_cmp
Shenandoah River
Highways
Perennial Streams
Intermittent Streams
County Boundary

Figure 2


Physiographic Provinces
of
Clarke County, Virginia
Opequon Creek
Long Marsh Run
Dry Marsh Run
340
7
Isaac Run
Buck Marsh Run
Wheat Spring Branch
Dog Run
Craig Run
Dog Run
River
Spout Run
Valley Region
Roseville Run
Chapel Run
Morgan Mill Stream
Westbrook Run
Brook
Spout Run
Blue Ridge Region
Wrights Run
340
17
50
Shenandoah
Borden Marsh Run
Long Branch
Wallis Marsh Run
Wrights Branch
Shenandoah River
Highways
Perennial Streams
Intermittent Streams
County Boundary
0 Inches 1
0 Miles 2.5
N
THE COUNTY OF CLARKE VIRGINIA 1836
Clarke County GIS
April 16, 1999
/d1/arcdata/nad83/swmgmt2_cmp

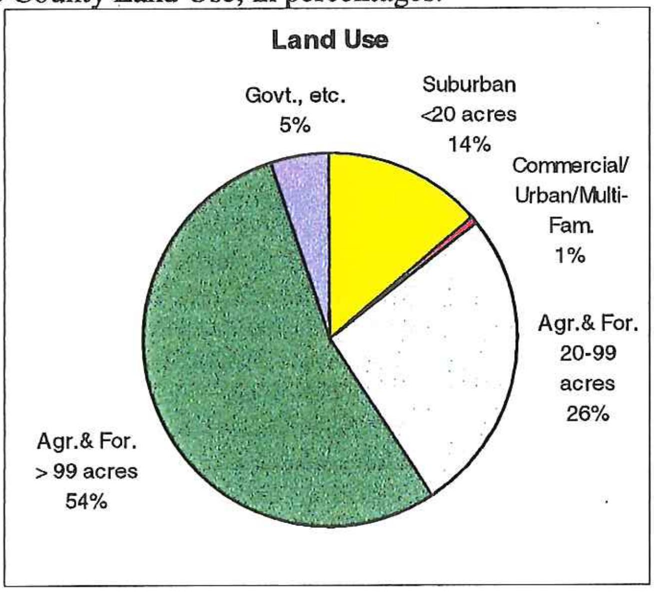
Principal land uses in Clarke County include agriculture, forestry, and residential, commercial, and governmental uses. As indicated in table 1 and figure 3, 80% of the land area in the County is classified as agricultural, including forestal uses. The majority of forestry activities are located on the mountain, east of the Shenandoah River.

Table 1. Clarke County Land Use, in Acres

	Total Number of Parcels	Total Acres	Percent Acreage
Single family residential- urban (in incorporated towns)	1,175	900	1
Single family residential- suburban (not in incorporated towns, less than 20 acres in parcel)	5,311	15,203	14
Multifamily	30	133	<1
Commercial/industrial	289	686	1
Agricultural and forestal (20 to 99 acres in parcel)	668	28,280	26
Agricultural and forestal (over 99 acres in parcel)	338	59,245	54
Exempt (government, churches, etc.)	316	5,619	5
Total	8,127	110,066	100

Source: Clarke County Real Estate Data Base, 1999

Figure 3. Clarke County Land Use, in percentages.



IV. Impacts to Surface Waters and State Agency Assessments of Water Quality

Land use activities represent the largest potential adverse impact to surface waters in Clarke County because of land disturbance that affects the stream corridor or riparian zone. The riparian zone is defined as the land adjacent to a body of water that serves as a transitional environment and directly affects or is affected by the presence of that water. A riparian buffer is an area maintained in permanent vegetation and managed to reduce the impacts of adjacent land uses. "Riparian buffers play a critical role in the landscape, protecting water quality by filtering runoff and removing nutrients and sediment; protecting living resources by supplying food, habitat and temperature-moderating shade; protecting the shoreline integrity from erosion impacts; and moderating flood damages." (Virginia Riparian Forest Buffer Panel 1998). Table 2 describes the contamination sources associated with principal land uses. Providing for and maintaining these buffers, in conjunction with reducing or eliminating contamination sources, are the most effective ways to improve surface water quality in the County.

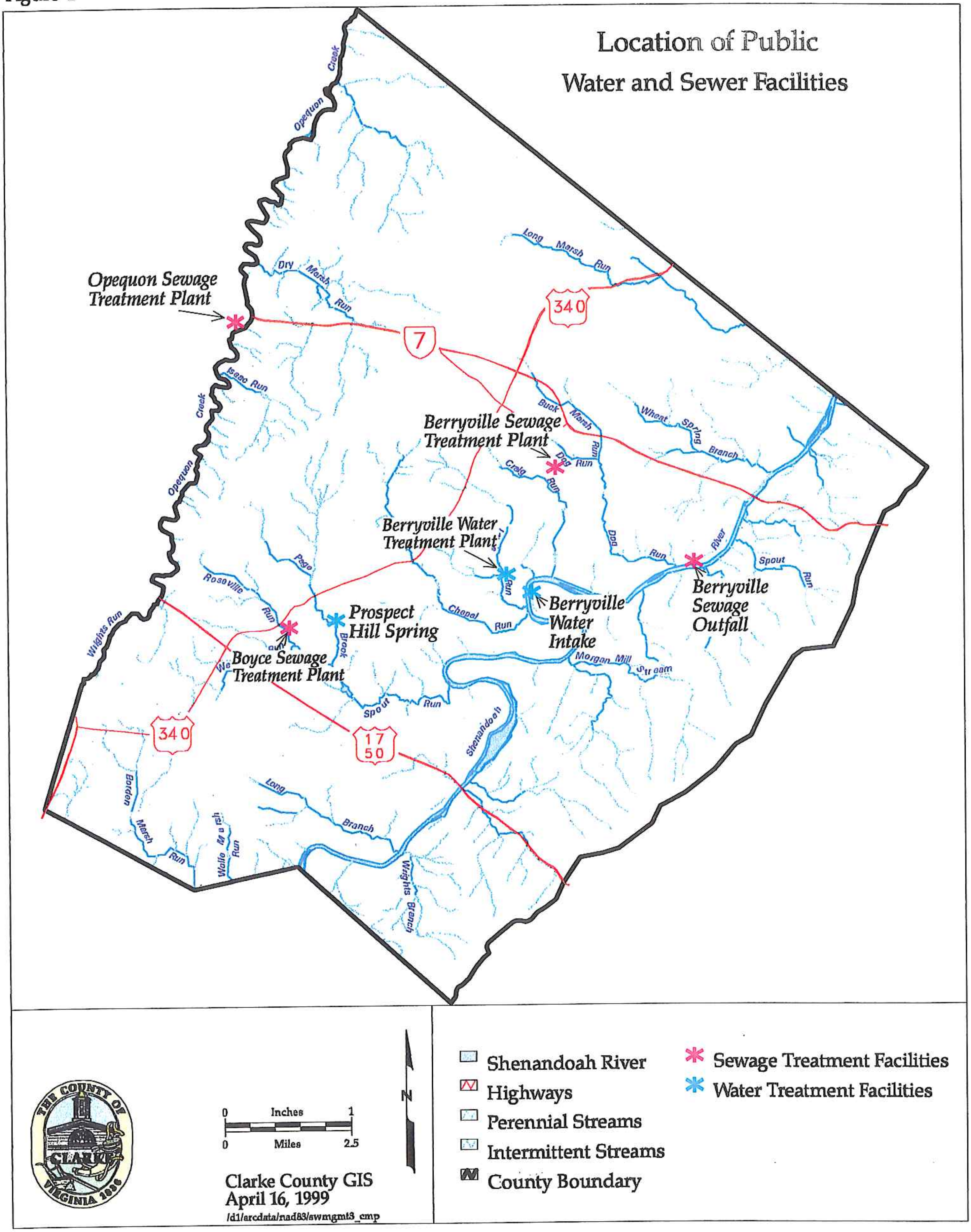
Table 2. Contamination Threats to Surface Water Associated with Principal Land Uses in Clarke County

LAND USE	LAND USE ACTIVITY	TYPE OF CONTAMINATION
Agriculture	Animal feed lots Manure spreading and pits Grazing with unlimited access to streams Chemical application Chemical storage areas	Coliform bacteria, pesticides, fungicides, fertilizers- nitrates
Residential	Septic systems Lawn chemicals, fertilizers	Coliform bacteria, chemicals, nitrates, fungicides, fertilizers
Commercial and industrial	Auto repair Construction areas Car washes Gas stations Paint shops Road deicing operations Storage tanks Storm water runoff	petroleum chemicals detergents salts fertilizers– nitrates
Other uses	Transportation railroad trucking	Petroleum chemicals variety of contaminants

Source: U. S. Environmental Protection Agency 1989

Clarke County's surface waters are affected by five major impacts: chemical discharges, point source pollution, nonpoint source pollution, instream/offstream conflicts, and development. These five threats are described in more detail in the following subsections (LFPDC 1990).

Figure 4



Location of Public
Water and Sewer Facilities
Opequon Sewage Treatment Plant
Berryville Sewage Treatment Plant
Berryville Water Treatment Plant
Prospect Hill Spring
Berryville Water Intake
Berryville Sewage Outfall
Boyce Sewage Treatment Plant
Opequon Creek
Dry Marsh Run
Long Marsh Run
Isaac Run
Buck Marsh Run
Wheat Spring Branch
Dog Run
Craig Run
Roseville Run
Page Brook
Chapel Run
Spout Run
Morgan Mill Stream
Shenandoah River
Wrights Run
Borden Marsh Run
Wolfe Marsh Run
Long Branch
Wrights Branch
7
340
17 50
Inches
Miles
0
1
2.5
N
Clarke County GIS
April 16, 1999
/d1/arcdata/nad83/swmgmt3_cmp
Shenandoah River
Highways
Perennial Streams
Intermittent Streams
County Boundary
Sewage Treatment Facilities
Water Treatment Facilities
THE COUNTY OF CLARKE VIRGINIA 1836

discharged by Berryville and the Boyce treatment facilities meets State water quality standards. However, there is no minimum standard for nitrates or phosphorus and these nutrients are discharged into the Shenandoah River and Roseville Run. DEQ periodically collects water quality samples that measure nutrients including nitrates. In addition, members of the Friends of the Shenandoah River collect water samples from the outflow of these plants. As described in the following charts, these samples have identified high nitrate levels, indicating that sewage treatment plants are contributing to the nutrient enrichment of surface waters (figures 5 and 6).

Figure 5. Outfall data from the Berryville Sewage Treatment Facility, Berryville Virginia.

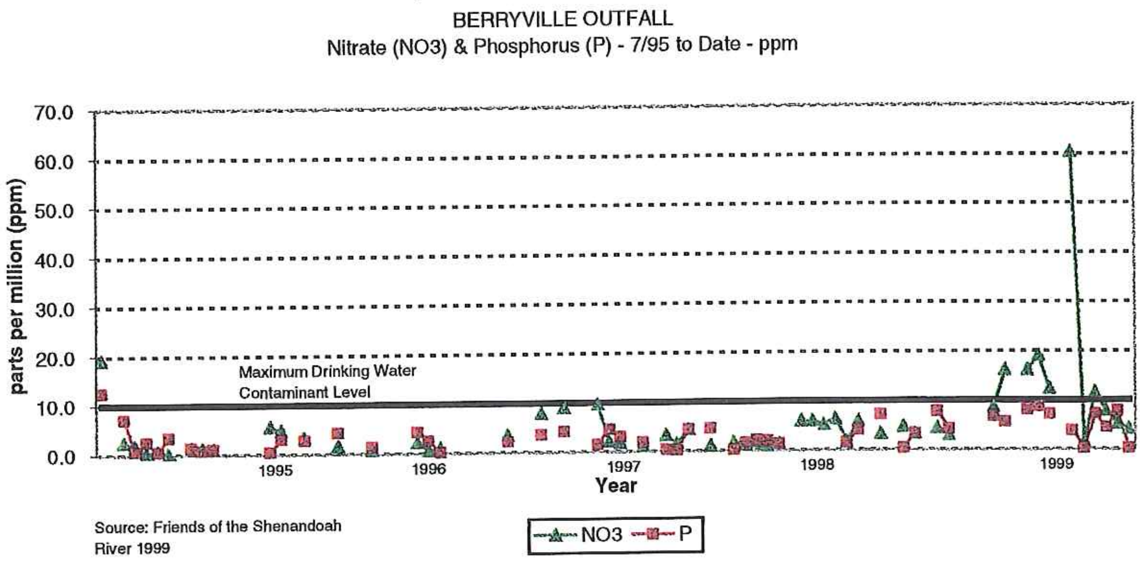
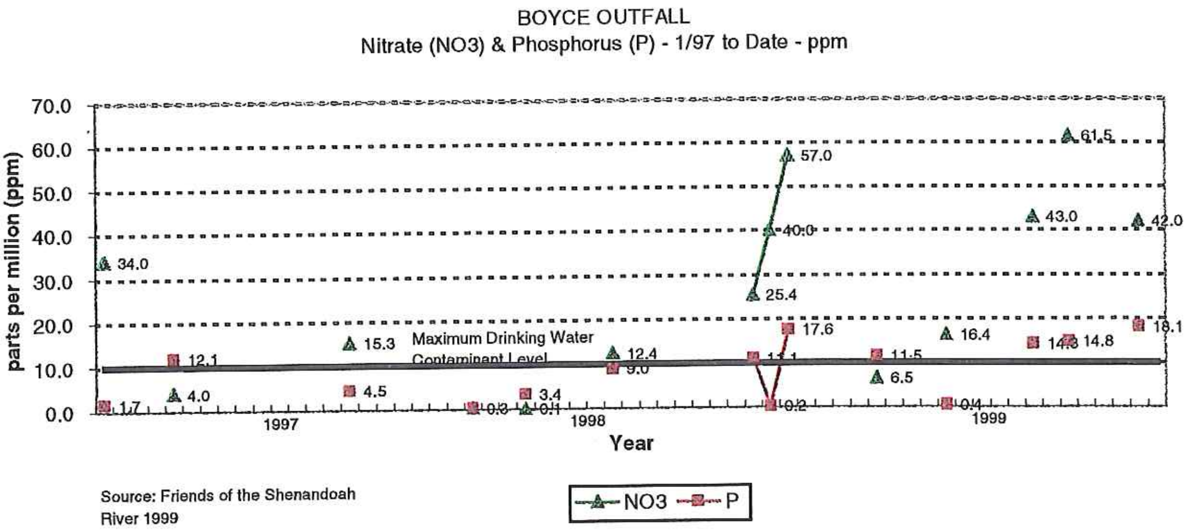


Figure 6. Outfall data from the Boyce Sewage Treatment Facility, Boyce Virginia.



In contrast, of all the stream sample sites (n=12) (figure 7), none exceeded 10 ppm nitrates for any sample (n=800) collected from 1995 to 1999. This finding indicates that agricultural practices are not contributing significantly to the nutrient enrichment of the tributaries that were sampled. Additional data collection is necessary to provide a thorough water quality assessment of all streams in the County. Other point sources may include individual sewage disposal via straight pipes. Although these systems are no longer permitted in the County, some may exist that were installed before the adoption of the Septic Ordinance, in 1987. Additional study is needed to determine the extent of these systems.

C. Nonpoint Source Pollution

Nonpoint source pollution is caused by many diffuse sources. These inputs do not come from a specific, single location but from runoff, precipitation, or percolation. The Department of Environmental Quality (DEQ) and Department of Conservation and Recreation (DCR) are responsible for monitoring, assessing, and compiling data collected in State waterways. When nonpoint source pollution is assessed, streams are evaluated within the context of a watershed. DCR defines a watershed, or hydrologic unit, as a land area drained by a river or stream or a system of connecting rivers and streams such that all water within the area flows through a single outlet (VDCR 1997).

Nonpoint source pollution (NPS) originates from almost all land uses, including farmland, urban areas, construction sites, and forestland. Farms may yield sediment, pathogens, toxic substances, and excess nutrients. Urban and suburban areas may also contribute significant levels of nutrients as well as toxic substances, pathogens, and sediment. City streets and other impervious surfaces yield NPS pollutants such as motor oil, gasoline, antifreeze, and other toxic chemicals. Because these surfaces do not absorb rainwater, runoff from urban areas is nine times greater than from forestland (VDCR 1997).

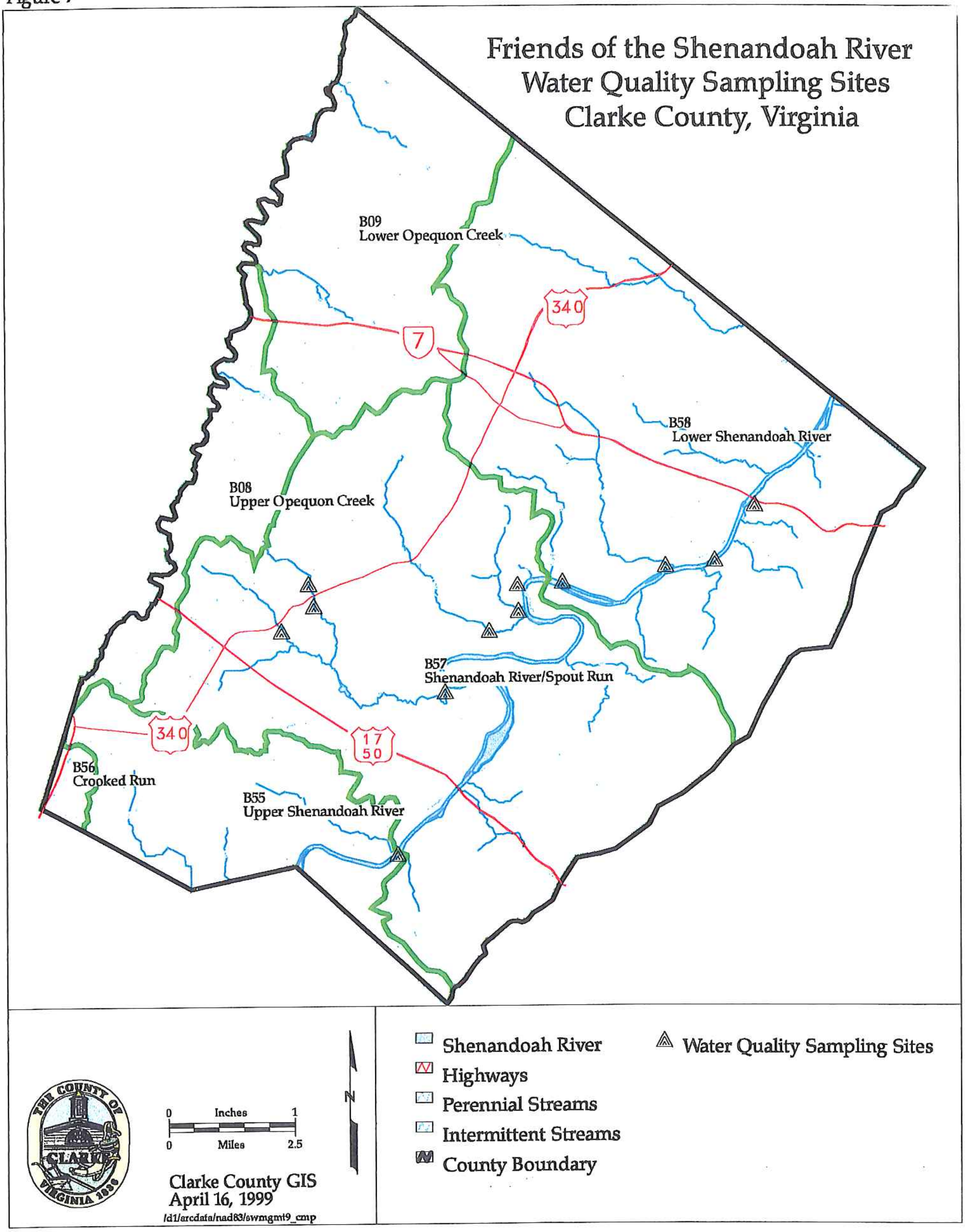
In determining the impacts of nonpoint sources, local governments rely on State and Federal agencies to assess contamination levels and pollution potential for watersheds within the locality. Ongoing State agency activities used to describe impacts include: nonpoint source pollution assessments (DCR), natural heritage rankings (Department of Natural Heritage (DNH)), total maximum daily load (TMDL) evaluations (DEQ), and the Tributary Strategy Planning Process (DCR, DEQ, and others).

Understanding nonpoint source pollution in Clarke County is important, as most surface water contamination can be attributed to nonpoint sources such as agricultural practices, lawn fertilization, failing septic systems, and road deicing. Understanding the extent of contamination assists the County in allocating limited resources to the watersheds with the highest need for improvement.

1. Nonpoint Source Pollution Watershed Assessment

The DCR Division of Soil and Water Conservation (DSWC) is the lead agency for the management and implementation of Virginia's Nonpoint Source (NPS) Control Programs. Virginia's NPS Program was developed in accordance with Section 319 of the Clean Water Act of 1987.

Figure 7


Friends of the Shenandoah River
Water Quality Sampling Sites
Clarke County, Virginia
B09
Lower Opequon Creek
340
7
B58
Lower Shenandoah River
B08
Upper Opequon Creek
B57
Shenandoah River/Spout Run
340
17
50
B56
Crooked Run
B55
Upper Shenandoah River
Shenandoah River
Highways
Perennial Streams
Intermittent Streams
County Boundary
Water Quality Sampling Sites
N
0
Inches
1
0
Miles
2.5
Clarke County GIS
April 16, 1999
/d1/arcdata/nad83/swmgmt9_cmp

The DCR-DSWC developed a NPS Pollution Assessment Report, which was approved by EPA in July 1989. This report was revised in March 1993 and again in 1997. The report delineated 491 watersheds or hydrologic units within Virginia and prioritized them for NPS pollution concerns. The priorities were developed primarily from two types of data. The first type includes inventory data related to specific land uses, animal density, and other related factors. The inventory data consist of livestock inventories, land use, and soil erosion rates. These data are compiled from 1992 Census of Agriculture, 1990 National Survey of Conservation Tillage Practices, 1992 Natural Resource Inventory, and the 1991 Hydrologic Unit Database. These data were further evaluated and updated specifically for each County by representatives from DCR, Natural Resource Conservation Service (NRCS), Soil and Water Conservation District (SWCD), Farm Services Agency (FSA), Cooperative Extension Service (CES), and Department of Forestry (VDOF). The inventory data were collected to address the NPS potential from three major land use categories: agricultural, urban, and forestry. The second type of data consist of available water quality monitoring information. Water quality data were provided to serve as background information and to identify watersheds with known water quality problems (VDEQ 1998). An overall NPS priority is based on a weighted combination of the total priority results from the urban, agricultural, and forestal sources. The prioritization of watersheds is used by the state for allocation of cost-share funds. In all, six hydrologic units, as designated by the State DSWC, are either wholly or partially within Clarke County. These include B08 (Upper Opequon Creek), B09 (Lower Opequon Creek), B55 (Upper Shenandoah River), B56 (Crooked Run), B57 (Shenandoah River/Spout Run), and B58 (Lower Shenandoah River) (figure 8) (VDCR 1997). Table 3 summarizes the rankings as described in the Assessment Report.

Table 3. Overall Nonpoint Source Pollution Priorities

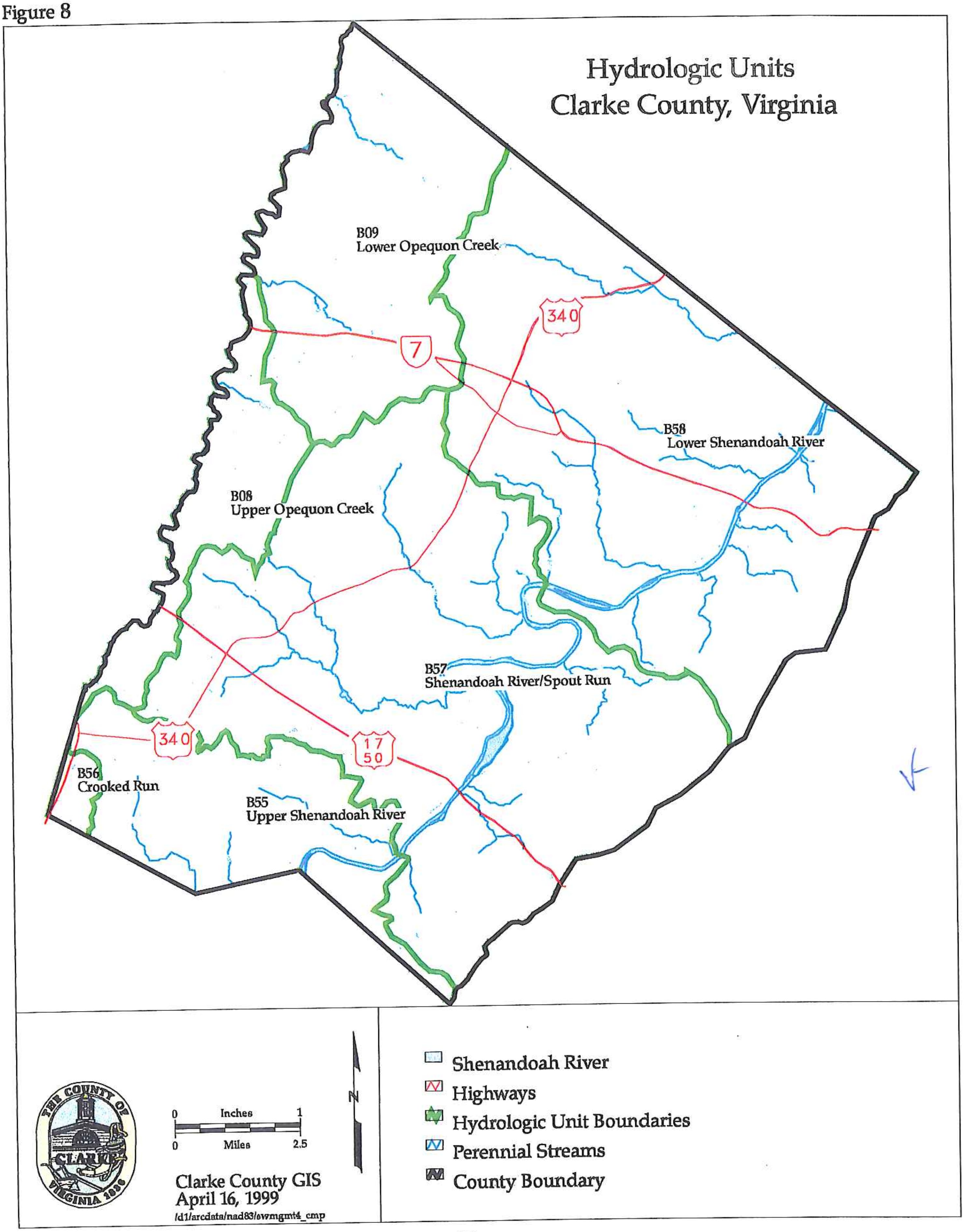
Watershed Name	NPS Agricultural Priority	NPS Urban Priority	NPS Forestry Priority	NPS Overall Priority	TMDL Priority
Upper Opequon Creek	Medium	High	Low	Medium	
Lower Opequon Creek	Medium	High	Low	Medium	Medium
Upper Shenandoah River	Low	High	Low	High	
Crooked Run	Low	High	Low	Medium	
Shenandoah River/Spout Run	Medium	Medium	Low	High	
Lower Shenandoah River	Low	Medium	Low	Low	

Source: Virginia Department of Conservation and Recreation 1997

2. Total Maximum Daily Load (TMDL)

Determining the amount of contamination a stream can assimilate without degrading water quality below the state water quality standards is the purpose of establishing TMDLs. Water quality standards consist of statements that describe water quality requirements. They also contain numeric limits for specific physical, chemical, biological, or radiological characteristics of water. These statements and numeric limits describe water quality necessary to meet and maintain uses such as swimming, fishing, and other water-based recreation, public water supply, and the propagation and growth of aquatic life (VDEQ 1996).

Figure 8


Hydrologic Units
Clarke County, Virginia
B09
Lower Opequon Creek
340
7
B58
Lower Shenandoah River
B08
Upper Opequon Creek
B57
Shenandoah River/Spout Run
340
17
50
B56
Crooked Run
B55
Upper Shenandoah River
THE COUNTY OF
CLARKE
VIRGINIA 1836
Inches
0
1
Miles
0
2.5
N
Clarke County GIS
April 16, 1999
/d1/arcdata/nad83/swmgmt4_cmp
Shenandoah River
Highways
Hydrologic Unit Boundaries
Perennial Streams
County Boundary

Those streams whose water quality currently does not meet minimum standards are declared "impaired" waterways. This designation or "priority ranking" is important to localities for targeting limited resources for stream improvements. DEQ in conjunction with DCR has developed the Total Maximum Daily Load (TMDL) Priority List. Under Section 303(d) of the Clean Water Act, water quality is measured by whether or not streams fully support beneficial uses such as fishing and swimming. The TMDL process establishes water quality based controls when streams do not fully support beneficial uses. The TMDL prioritization process complements the Tributary Strategy Planning and NPS Assessment process described above by prioritizing the level of impairment of various watersheds. This process helps to focus the use of limited resources to watersheds that will have the greatest impact on reducing nutrient levels, improving habitat, and reducing bacteria levels.

3. Natural Heritage Resource Priority Ranking

Natural heritage resources are defined by the Virginia Natural Area Preserves Act as "The habitat of rare, threatened, or endangered plant and animal species, rare or significant natural communities or geologic sites, and similar features of scientific interest" (Virginia Code 1998 sec. 10.1-209 et seq.). Hydrologic units are ranked and prioritized by DNH according to the presence of wetland and aquatic natural heritage species. The more species found in a watershed, the higher the priority. These priorities are intended to help direct nonpoint source pollution mitigation efforts and other water quality improvement projects toward those watersheds in which natural heritage resources will benefit from the maintenance or enhancement of water quality (VDCR, 1997) (figure 9).

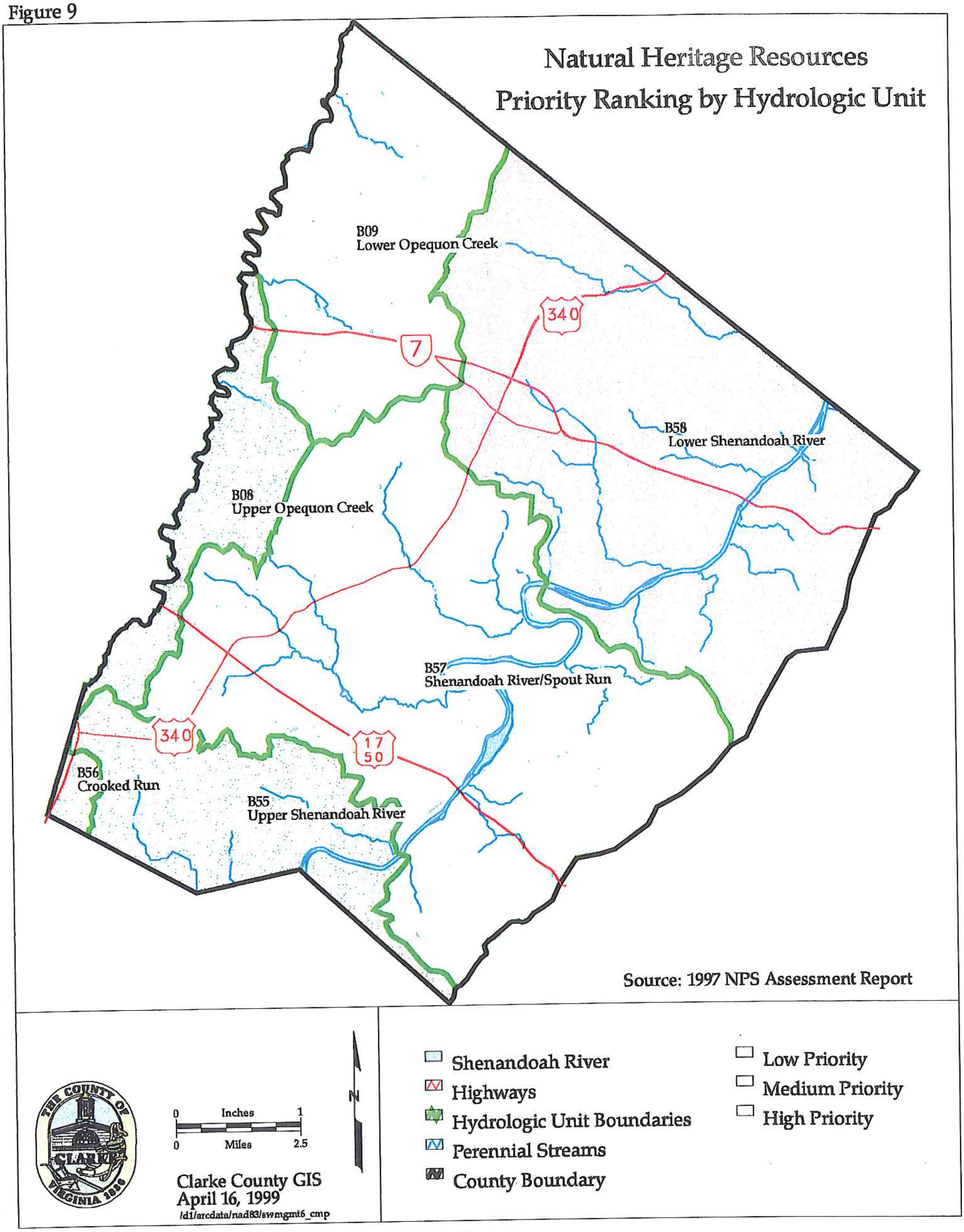
4. Tributary Strategies

An additional State effort to protect surface waters is the Tributary Strategy Planning process. The need to reduce the nutrient flow from tributaries into the Chesapeake Bay prompted States, including Virginia, to enter into the Chesapeake Bay Agreement in 1987. This agreement contains a commitment to reduce the controllable loads of phosphorus and nitrogen entering the Bay by 40% by the year 2000 by developing tributary-specific strategies for each of the Bay's major tributaries. Virginia's strategy for the Shenandoah and Potomac River Basin was completed in 1996 (Commonwealth of Virginia 1996).

D. Contamination Assessment

Data were collected and compiled by DCR, as described above, to address the NPS potential from three major land use categories: agricultural, urban, and forestry. Water chemistry and biological samples are collected by DEQ to identify watersheds with known water quality problems, but are not collected for all streams in the County. Members of the Friends of the Shenandoah River (FOSR) collect additional water chemistry for several streams and the Shenandoah River. In addition, three watershed restoration projects are ongoing in the Spout Run watershed. Intensive water quality sampling is being conducted to show water quality changes as the result of BMP installation. The following assessments of the watersheds and streams in Clarke County were derived from the available information.

Figure 9


Natural Heritage Resources
Priority Ranking by Hydrologic Unit
B09
Lower Opequon Creek
B08
Upper Opequon Creek
B58
Lower Shenandoah River
B57
Shenandoah River/Spout Run
B56
Crooked Run
B55
Upper Shenandoah River
340
7
17
50
Source: 1997 NPS Assessment Report
Inches
Miles
0
1
0
2.5
N
THE COUNTY OF
CLARKE
VIRGINIA 1836
Clarke County GIS
April 16, 1999
/d1/arcdata/nad83/swmgmt6_cmp
Shenandoah River
Highways
Hydrologic Unit Boundaries
Perennial Streams
County Boundary
Low Priority
Medium Priority
High Priority

1. Known Contamination Problems (figure 10)
    a. Spout Run

Water quality in the Spout Run watershed is being monitored extensively by the County as part of watershed restoration projects funded by State and EPA grants. The projects are designed to show how installation of BMPs can improve water quality. These studies are described in detail later in this report. Beginning in 1996, water samples were collected from streams, wells, and springs in the study area (figure 11). These samples were analyzed for chemical parameters and coliform bacteria. To date more than 1,700 samples have been processed for fecal coliform (table 4) (Hagedorn 1999).

Table 4. Monitoring Results for Fecal Coliforms in the Spout Run Watershed

Watershed	Well Water Samples		Stream Samples		
Basin	# Samples	#(%) Positive	# Samples	#(%) Positive	#(%) > 1,000
Page Brook (PB)	193	20 (10.4)	203	125 (61.6)	27 (21.6)
Roseville Run (RR)	195	27 (13.8)	188	175 (93.1)	44 (25.1)
Spout Run (SR)	31	2 (6.5)	48	45 (93.8)	9 (20.0)
Total	419	49 (11.7)	439	345 (78.6)	80 (23.2)

The regulatory standard for fecal coliforms is zero for drinking water, and no more than 1,000 per 100 ml for recreational water

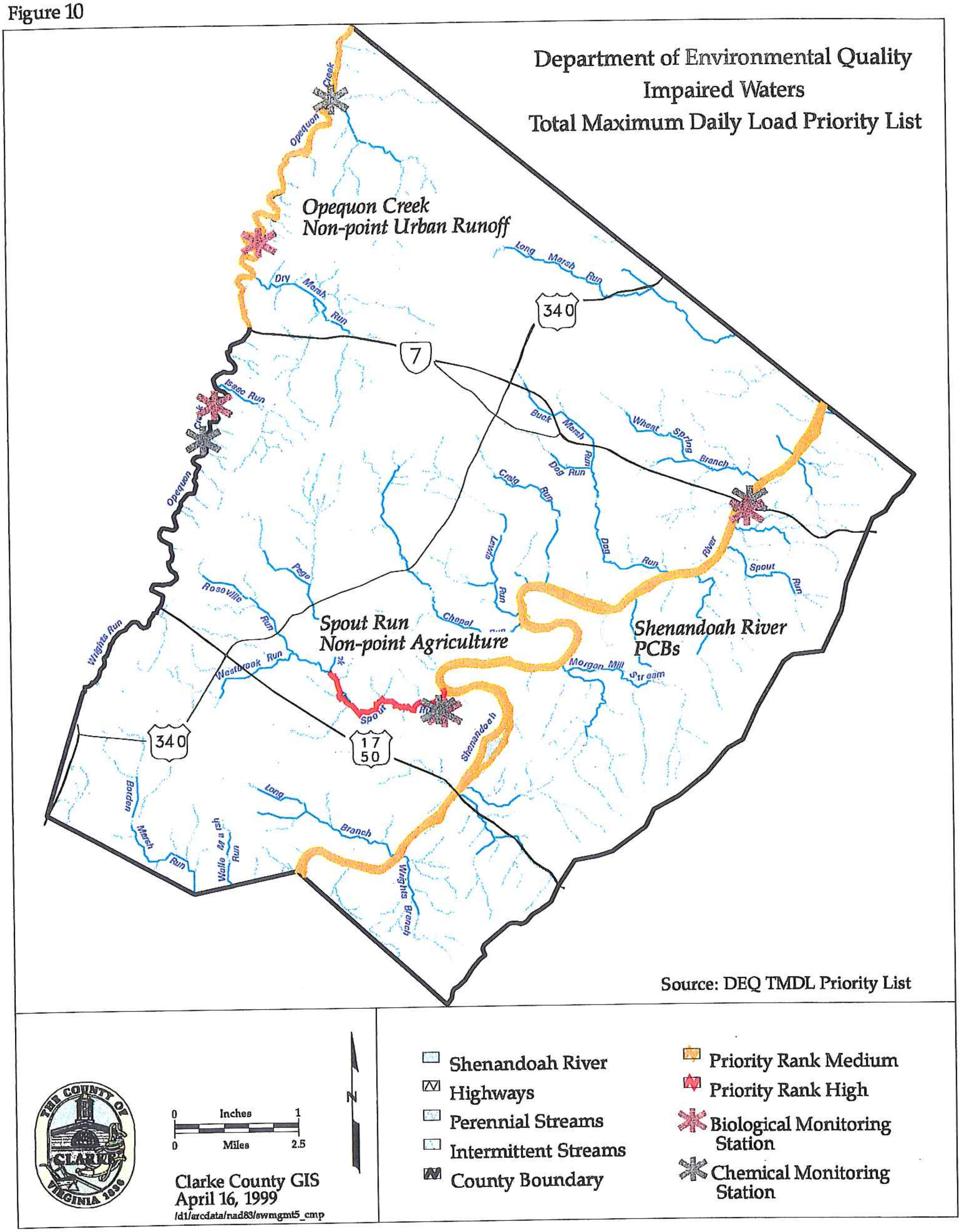
In addition, bacterial source tracking (BST) methodology is used to identify sources of fecal pollution. For the Page Brook and Roseville Run segments of the watershed, BST has identified livestock or wildlife as the primary source of contamination. BMPs were implemented in the Page Brook section to limit livestock access to the stream, resulting in large reductions in fecal coliform populations in the stream (Hagedorn 1999). Work is ongoing to identify sources in Spout Run.

The conclusions drawn from these sample results indicate that substantial fecal pollution of well water is not occurring at this time, in this watershed. This finding is in contrast to previous studies conducted County wide in 1986 and 1991, which identified 40% of the wells sampled contaminated by coliform (Wright 1991, Ross et. al. 1991). However, streams in this watershed are highly polluted. Reducing the fecal loading in surface waters is a critical step in protecting ground and drinking waters.

Due to the distances involved fecal pollution in the watershed is not making a substantial contribution to coliform levels in the Chesapeake Bay. At present, the major impact of fecal pollution in the watershed is the degradation of recreational water quality both in the streams and in the Shenandoah River. This degradation reduces the quality of recreational pursuits and represents a health risk for all types of water contact activities (Hagedorn 1999).

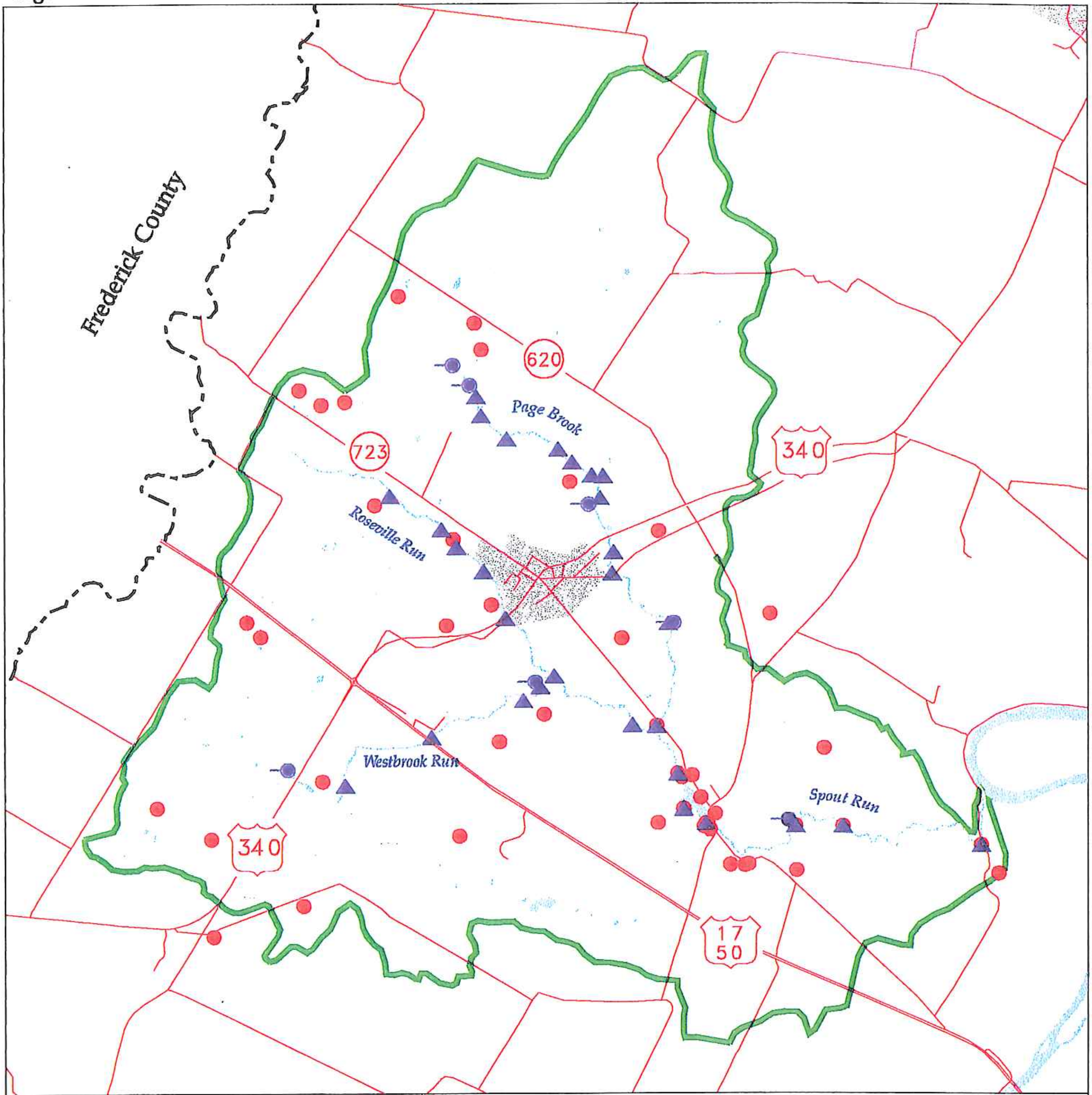
Spout Run has been listed as an impaired waterway by DEQ, beginning at the confluence of Roseville Run and Page Brook and extending down to its conflux with the Shenandoah River. The impairment is listed as fecal coliform bacteria. Data collected at the Route 621 bridge indicate moderate impairment. The impairment source is listed as nonpoint source

Figure 10

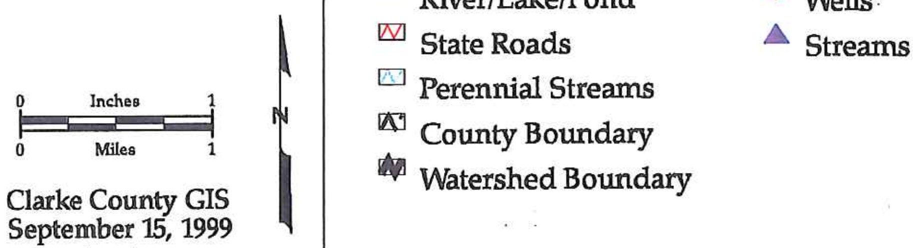


Department of Environmental Quality
Impaired Waters
Total Maximum Daily Load Priority List
Opequon Creek
Non-point Urban Runoff
Spout Run
Non-point Agriculture
Shenandoah River
PCBs
Opequon Creek
Long Marsh Run
Dry Marsh Run
340
7
Isaac Run
Buck Marsh Run
Wheat Spring Branch
Dog Run
Craig Run
Lewis Run
Page
Roseville Run
Chapel Run
Westbrook Run
Spout Run
Spout Run
River
Morgan Mill Stream
Wrights Run
340
17
50
Shenandoah
Long Branch
Borden Marsh Run
Walle Marsh Run
Wrights Branch
Source: DEQ TMDL Priority List
Inches
0
1
Miles
0
2.5
N
THE COUNTY OF CLARKE VIRGINIA 1836
Clarke County GIS
April 16, 1999
/d1/arcdata/nad83/swmgmt5_cmp
Shenandoah River
Highways
Perennial Streams
Intermittent Streams
County Boundary
Priority Rank Medium
Priority Rank High
Biological Monitoring Station
Chemical Monitoring Station

Figure 11



Spout Run Watershed
Water Quality Sampling Sites



Clarke County GIS
September 15, 1999
/d1/arcdata/nad83/spoutpts2_cmp

(NPS)- Agriculture, based on the assessment by DCR of this waterbody's having a high potential for nonpoint source pollution from agricultural lands. Although the source is listed as nonpoint agriculture, source differentiation tests were not conducted. Preliminary sampling by the County has identified human sources below Millwood, and failing or inadequate sewage disposal in Millwood as a probable source for this contamination.

b. Opequon Creek
Impairment begins at the confluence with Abrams Creek just north of Route 7 and continues to the West Virginia State line. Biological monitoring indicated a moderately impaired benthic community. The source is believed by DCR to be nonpoint source urban runoff.

c. Shenandoah River
Impairment begins at the Route 619 bridge in Front Royal and ends at the West Virginia State line. The impairment cause is listed as PCBs generated from the former Avtex Fibers Plant in Front Royal. The Virginia Department of Health has issued a Health Advisory recommending that fish from the river not be consumed.

2. Streams monitored by Friends of the Shenandoah River
In 1995, the Friends of the Shenandoah River (FOSR) developed a Shenandoah River Basin monitoring network to assess the water quality in the Shenandoah River and its tributaries. Water chemistry parameters including nitrates, ammonia, phosphates, pH, dissolved oxygen (DO), turbidity, and coliform are tested. In Clarke County, four sites along the Shenandoah River are monitored, in addition to sites on Page Brook, Spout Run, Lewis Run, and Dog Run. The FOSR also collects samples at the outfall of the Boyce and Berryville sewage treatment facilities. Samples are analyzed at a grant-funded laboratory located at Shenandoah University. As described earlier, the water chemistry parameters evaluated for these streams indicate low nutrient loading impacts. Coliform levels have not been measured, however, and where livestock or failing septic systems are present, contamination may be present. Additional monitoring is required to adequately evaluate the water quality of these streams.

3. Streams Susceptible to Contamination (figures 12 and 13)
In Clarke County, six water monitoring stations are sampled by DEQ: four on the Opequon Creek, one on Spout Run, and one on the Shenandoah River. Contamination levels are known for these three streams. All other streams are evaluated on a watershed basis as to their susceptibility to contamination based on livestock inventories, land use, and soil erosion rates. The following hydrologic units are located at least partly within Clarke County and are characterized as to the potential for surface water contamination in the 1997 Nonpoint Source Pollution Watershed Assessment Report (VDCR 1997). Actual contamination levels within these watersheds can be determined by water sampling. The following summaries describe each watershed. Land cover data are derived from 1985 aerial photography compiled and evaluated in the Clarke County Geographic Information System (GIS).

a. Shenandoah River/Spout Run (B57)
The Shenandoah River/Spout Run hydrologic unit is located completely within Clarke

Figure 12

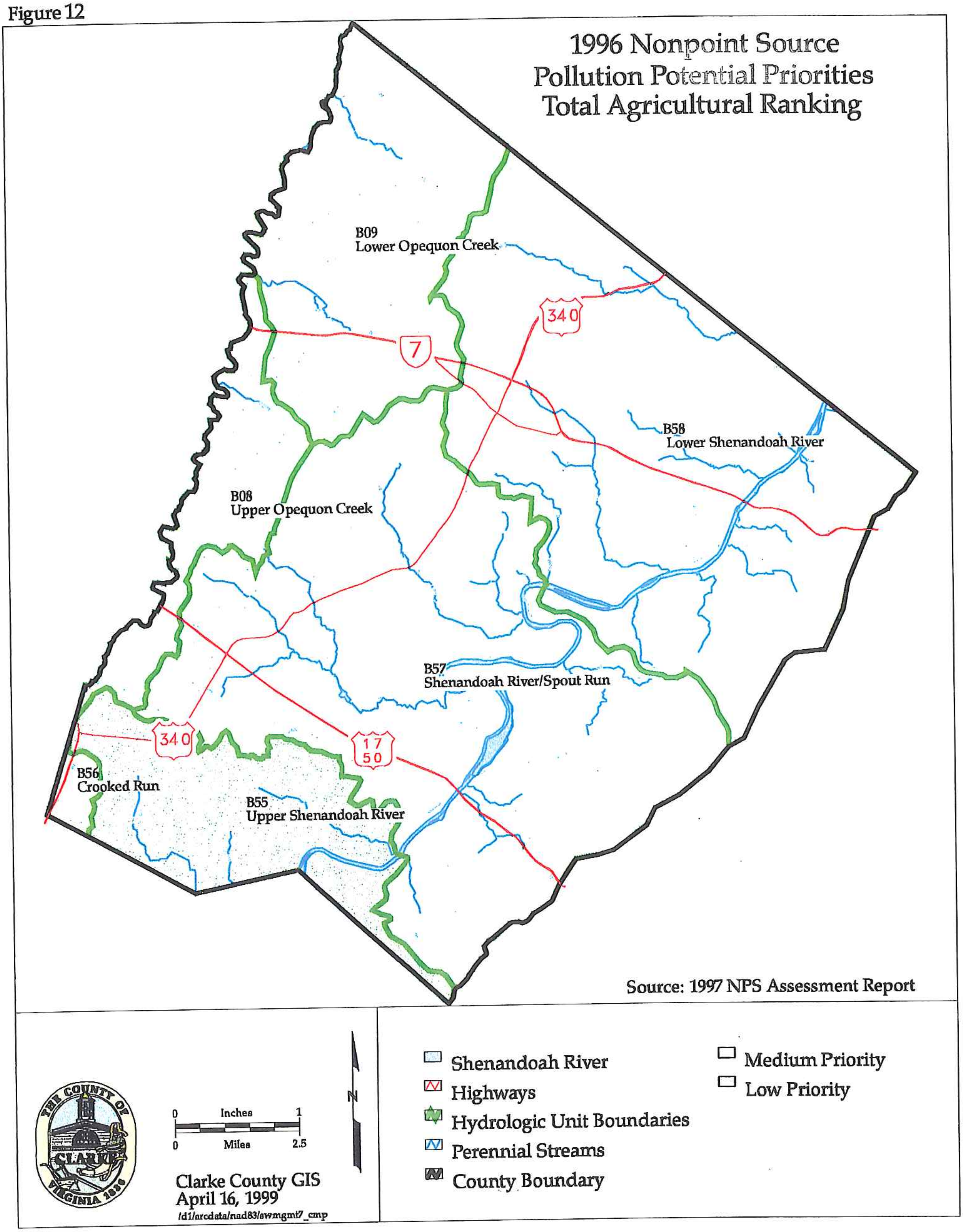
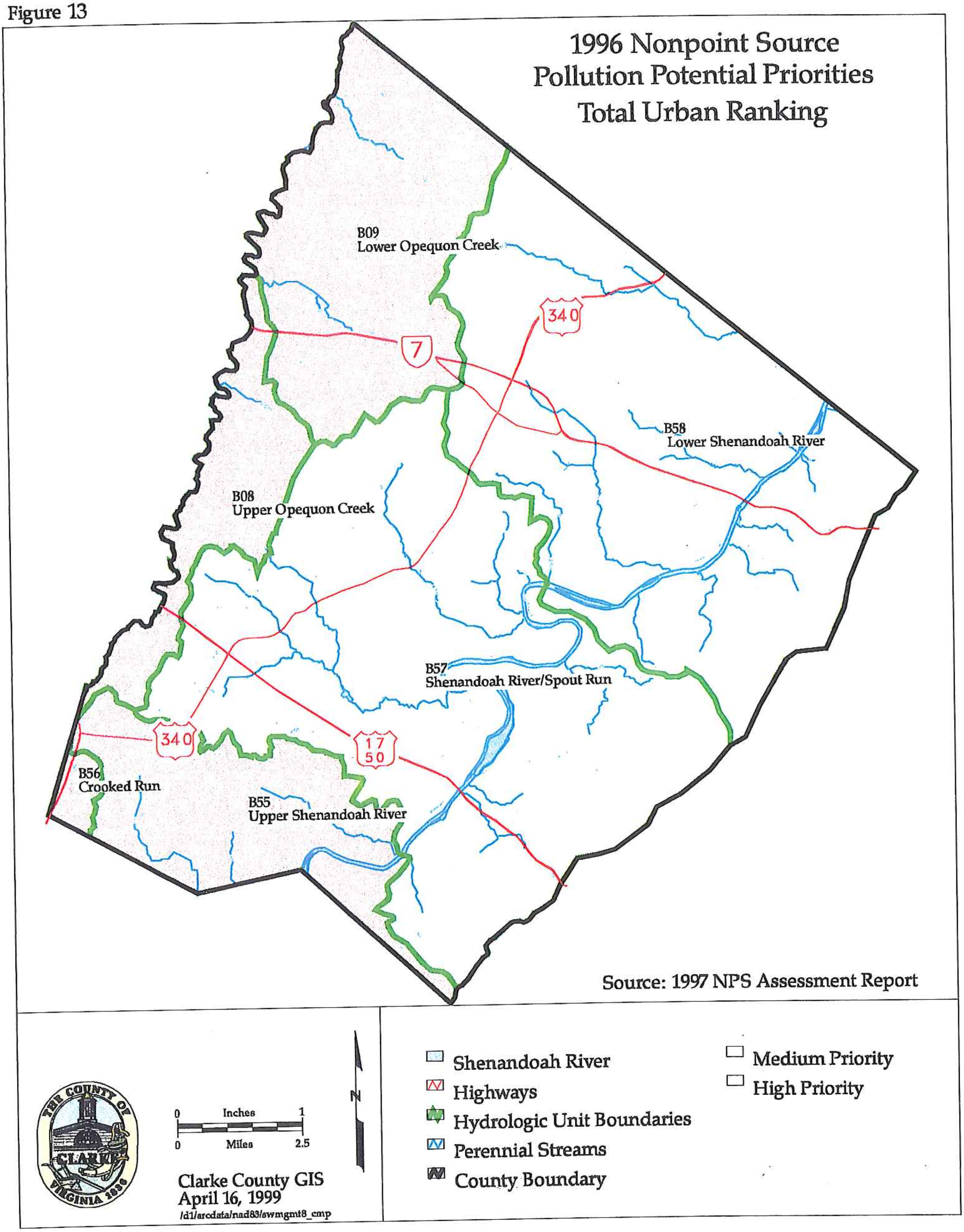

1996 Nonpoint Source
Pollution Potential Priorities
Total Agricultural Ranking
B09
Lower Opequon Creek
340
7
B58
Lower Shenandoah River
B08
Upper Opequon Creek
B57
Shenandoah River/Spout Run
340
17
50
B56
Crooked Run
B55
Upper Shenandoah River
Source: 1997 NPS Assessment Report
THE COUNTY OF
CLARKE
VIRGINIA 1836
0
Inches
1
0
Miles
2.5
N
Clarke County GIS
April 16, 1999
/d1/arcdata/nad83/swmgmt7_cmp
Shenandoah River
Highways
Hydrologic Unit Boundaries
Perennial Streams
County Boundary
Medium Priority
Low Priority

Figure 13



1996 Nonpoint Source
Pollution Potential Priorities
Total Urban Ranking
B09
Lower Opequon Creek
340
7
B58
Lower Shenandoah River
B08
Upper Opequon Creek
B57
Shenandoah River/Spout Run
340
17
50
B56
Crooked Run
B55
Upper Shenandoah River
Source: 1997 NPS Assessment Report
THE COUNTY OF CLARKE VIRGINIA 1836
0 Inches 1
0 Miles 2.5
N
Clarke County GIS
April 16, 1999
/d1/arcdata/nad83/swmgmt8_cmp
Shenandoah River
Highways
Hydrologic Unit Boundaries
Perennial Streams
County Boundary
Medium Priority
High Priority

County and makes up 41% (46,380 acres) of the total land area. The land cover is 52% forested, 44% agriculture, and 4% urban. The unit encompasses the mountain region from Wileys Neck south to Shenandoah Farms. The Valley portion extends from just south of Berryville to White Post and west to the drainage divide with the Opequon Creek. Boyce, Millwood, and Waterloo are within this unit, as are the major subdivisions of Calmes Neck and Carefree Acres. Perennial tributaries include Lewis Run, Chapel Run, Page Brook, Roseville Run, West Brook, and Spout Run in the Valley region, and Morgans Mill Stream, Wrights Branch, and two unnamed streams in the Mountain region. The DCR NPS assessment report rates this unit as having a medium potential for both agricultural and urban contamination and low for forestry. The overall NPS priority is listed as high based on a weighted calculation of the combined three land categories. As mentioned earlier, DEQ has declared Spout Run impaired based on high fecal coliform counts in water samples taken from the bridge at Route 621. DEQ identified one source as nonpoint agriculture but did not conduct source differentiation tests. Preliminary sampling by the County has identified human sources below Millwood and contamination from failing or inadequate sewage disposal in Millwood as a probable source for this contamination. In addition, fieldwork has identified that many landowners within the impaired segment have already fenced the stream to exclude livestock. Understanding the source of fecal coliform as either human or animal will result in the determining the best use of limited resources to reduce fecal coliform levels in the stream. High human counts will emphasize use of resources towards on-site sewage disposal management and repair, while higher livestock counts may indicate additional fencing is necessary. Extensive water quality monitoring (50 sites) is being conducted by the County as part of three watershed protection projects ongoing in Page Brook and Roseville Run. Friends of the Shenandoah River (FOSR) are sampling Spout, Chapel and Lewis Runs. Establishing sampling sites for the mountain streams is recommended.

b. Lower Shenandoah River (B58)
This watershed encompasses 36,945 acres of Clarke County, or 32% of the land area. The unit extends into Jefferson County, but such areas are downstream of Clarke and therefore do not affect County water quality. Land use in the region is 55% agriculture, 40% forestal, and 5% urban. The area extends from Wileys Neck across to Berryville and north to the West Virginia line. Urban areas include Pine Grove, Shenandoah Retreat, and Berryville. Streams within the watershed include Craig Run, Dog Run, Buck Marsh Run, Wheat Spring Branch, and Long Marsh Run in the Valley region, and Spout Run, a second stream with this name in the County, and four unnamed streams in the Mountain region. NPS assessment rates this unit as having medium potential for agriculture and urban runoff and low potential for contamination from forestry activities. The overall priority is low. DEQ has two sampling sites, one for water chemistry and the other for biological sampling, just north of the Route 7 bridge. Establishing sampling sites for the tributaries is recommended. FOSR samples Dog Run at the Route 621 bridge.

f. Crooked Run (B56)
This area represents the smallest hydrologic unit in the County (<1% of the land area). It is located in the southwest corner of the County, just south of Double Tollgate. Only 795 acres, or 3% of the land area, of this basin is within Clarke County. Sixty-one percent is in Frederick County, and 36% is located in Warren County. The land area in Clarke County encompasses the headwaters of Crooked Run, which is identified as an intermittent drainage by the United States Geologic Survey (USGS). Land cover is 88% agricultural, 6% urban, and 6% forested. Overall, the unit has a high potential for urban contamination, a medium potential for agricultural contamination, and a low potential for forestal contamination, with a combined priority rating of medium, according to DCR. Camp 7, a minimum security prison, is located within this area and may contribute to the urban nonpoint source component. No water sampling is conducted within Clarke County, and none is recommended due to the lack of a perennial waterway.

E. Instream/Offstream Conflicts
In 1989, the Virginia General Assembly addressed the problem of instream vs. offstream beneficial uses of water. House Bill 1837 defined "beneficial use" to mean both instream and offstream uses. Instream beneficial uses include fish and wildlife habitat, waste assimilation, recreation, navigation, and cultural and aesthetic values. Offstream beneficial uses include domestic, agricultural, hydropower, commercial, and industrial uses. HB 1837 established State policy to protect instream beneficial uses.

Protection of instream uses requires a sufficient amount of flow, which may vary depending on the particular instream use and on the time of year. Establishment of an instream flow requirement is, therefore, partially a scientific question: how much water various uses require at various times. It is also, however, partially a political question: how much water people desire to allocate to specific uses (LFPDC 1990).

One of the features of the 1989 legislation (in HB 1841) was the proposed designation of Surface Water Management Areas (SWMA). In 1992, the Surface Water Management Area Regulation was adopted. This regulation permitted counties to initiate a SWMA proceeding by submitting a petition that shows a given stream meets the following three criteria: (1) the stream has substantial instream uses; (2) records indicate that damaging low flows could occur; and, (3) current or potential offstream uses are likely to exacerbate natural low flows to the detriment of instream uses. The SWMA designation is designed to establish incremental minimum instream flow rates for the river. Depending on the level of instream flow, water conservation will be required for water users. Conservation may range from voluntary reduction measures to mandatory reductions in water use until stream levels return to or exceed the minimum levels.

In 1990, Clarke and Warren Counties petitioned the Department of Environmental Quality to designate the Shenandoah River in Clarke and Warren Counties as a Surface Water Management Area. Beginning in 1993, a technical committee was formed, and a series of committee meetings were held in 1993 and 1994. These meetings concluded that additional data were needed to determine the minimum flows required to protect beneficial uses of the river during drought

Development can affect Clarke's surface water in several ways. Building that occurs near streams can alter their physical appearance, water and habitat quality, and/or recreational value. Increased wastewater disposal in rural areas may increase groundwater contamination that may ultimately affect surface water as well. Growth around a service area, on the other hand, may result in increased use of surface water for disposal of treated wastewater. Increased demand for offstream water may add to conflicts between offstream and instream uses. Finally, because groundwater provides the base flow in many perennial streams, increased groundwater use may adversely affect instream flows (LFPDC 1990).

V. Issues in Surface Water Management

In addition to contamination threats, comprehensive surface water resource management in Clarke County should address the following issues (LFPDC 1990):

A. the interrelationship of surface water with groundwater;
B. supply of water for traditional offstream uses, such as domestic supply and agricultural uses;
C. recreational uses and needs; and,
D. resource protection.

A. The Interrelationship of Surface Water with Groundwater

The processes and structures that connect surface water and groundwater influence both the quantity and quality of Clarke County's water resources. Groundwater inputs maintain the base flow in many streams, while groundwater levels in turn depend on recharge from precipitation infiltrating from the surface. Water moving between the surface and subsurface carries with it the chemical and biological constituents that determine its overall quality. Groundwater quality, therefore, is influenced by substances that initially entered surface water, and vice versa. This interrelationship is a basic reality of the County's water resources and must be considered in all water management decisions. These decisions are, however, complicated, requiring more technical information than is currently available. Better understanding of this interrelationship, therefore, should be a continuing objective of the County (LFPDC 1990).

B. Supply of Water for Traditional Offstream Uses, Such As Domestic Supply and Agricultural Uses

Section 62.1-44.38 of the Code of Virginia authorizes the State Water Control Board (currently DEQ) to prepare water supply plans for each river basin in the State. In 1988, the Shenandoah Water Supply Plan was published (VWCB 1988). The plans there in are intended to "encourage, promote and secure the maximum beneficial use and control thereof" of State water resources (VWCB 1988, p. xxiv) and include: (1) an estimate of current and projected water withdrawals and use for agriculture, industry, domestic use, and other significant categories of water users; (2) an estimate, for each major river and stream, of the minimum instream flows necessary during drought conditions to maintain water quality and avoid permanent damage to aquatic life in streams, bays, and estuaries; (3) an evaluation, to the extent practicable, of the ability of existing subsurface and surface waters to meet current and future water uses, including minimum instream flows, during drought conditions; (4) an evaluation of the current and future capability of public water systems to provide adequate quantity and quality of water; (5) identification of water corridor also reduce vegetation, allowing urban contaminants such as lawn fertilizers and septage to pollute waterways. In addition, impervious surfaces can adversely affect flood zones and reduce groundwater recharge. Regionally, efforts to protect riparian zones are mandated in coastal areas of Virginia and encouraged throughout the Bay watershed to reduce contaminants entering the Chesapeake Bay.

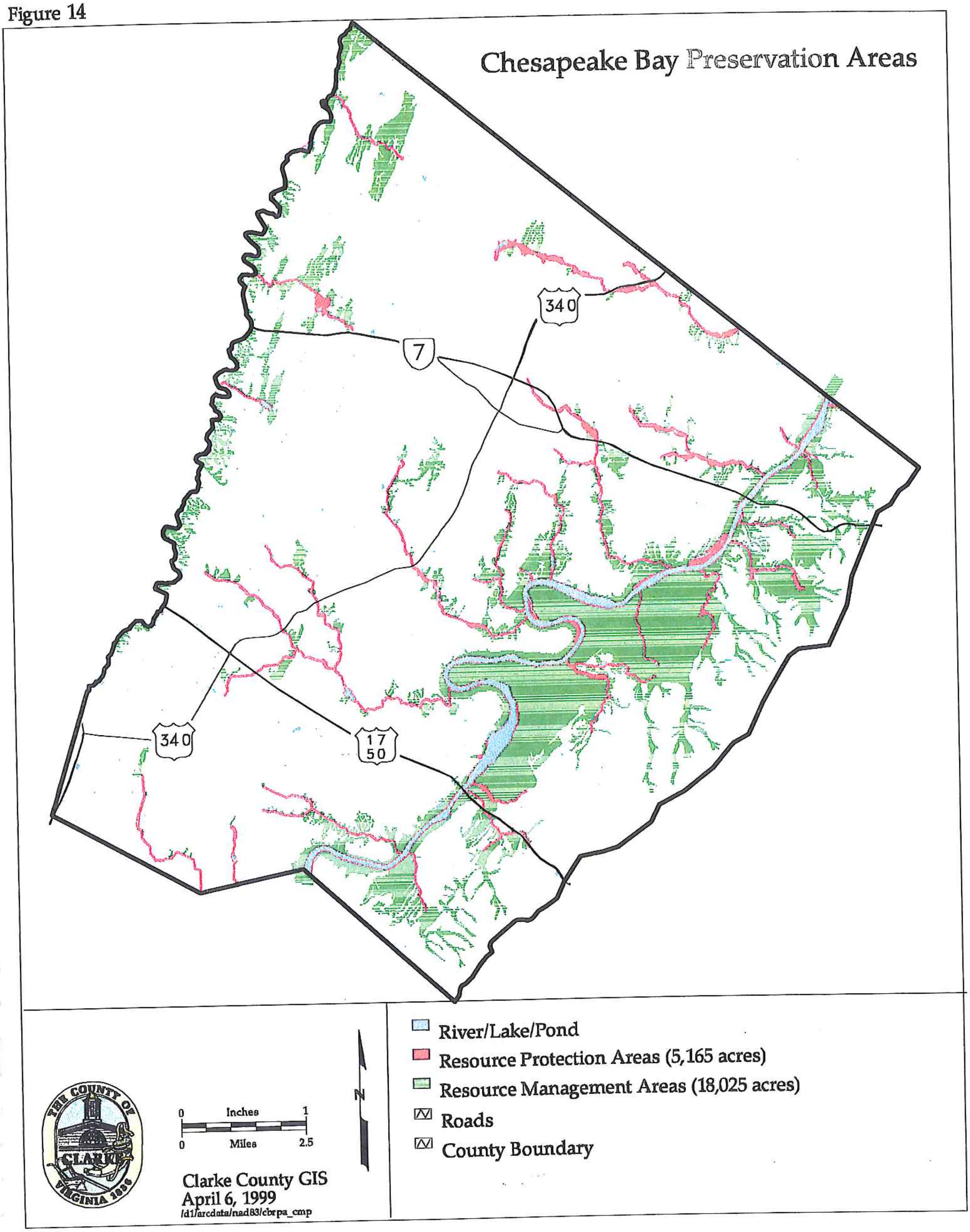
The Chesapeake Bay Preservation Act calls for the identification and protection of certain lands called Chesapeake Bay Preservation Areas (CBLAD 1997). The regulations governing these areas "establish criteria for use by local governments in granting, denying, or modifying requests to rezone, subdivide, or to use and develop land in Chesapeake Bay Preservation Areas" (CBLAD 1997, sec. 9VAC10-20-30). Currently, only the localities with tidal shoreline are required by State law to adopt the Preservation Area Regulations. However, all localities within the Bay watershed are encouraged by CBLAD to adopt pertinent portions of the regulations. Chesapeake Bay Preservation Areas are divided into Resource Protection Areas (RPAs) and Resource Management Areas (RMAs). Resource Protection Areas are the most sensitive areas and those where development and disturbance activity are most heavily regulated under current Bay Regulations. In Clarke County, these include buffer areas not less than 100 feet wide along both sides of any perennial stream or wetland areas adjacent to those streams. Resource management areas include floodplains, highly erodible soils, highly permeable soils, and nontidal wetlands not included in the RPAs (figure14).

Clarke County has already adopted several measures, including requiring 100% reserve areas for septic systems, amending the erosion and sediment control ordinance so that land disturbance exceeding 2,500 square feet is reviewed, and requiring building setbacks of 100 feet for perennial streams in the Mountain region. Additional regulations for consideration include mandatory septic pump-out, enhanced stormwater management regulations, and requiring 100-foot vegetated building setbacks from perennial streams within the Valley region of the County. These setbacks would serve to limit encroachment within the stream corridor, allowing contaminants from surface runoff to be filtered before entering the waterway.

VI. Current and Past Surface Water Quality Improvement Activities in Clarke County

Clarke County has been working to improve surface water quality as part of the Chesapeake Bay Cost-Share Program since 1985. The Cost-Share Program supports using various Best Management Practices (BMPs) in conservation planning for animal waste treatment, cropland, pastureland, and forested land. The Cost-Share Program pays a percentage up to 75%, with landowners responsible for the remaining 25% of the total cost of the BMP installation. In Clarke County, efforts have been directed toward installing BMPs on farms to reduce surface runoff into streams. Between 1989 and 1997, 34 farms participated in the Cost-Share Program to create a total of 1,900 acres of riparian buffer. With the increase in funding levels over the last two years, approximately 20 additional farms will begin installing a variety of BMPs designed to improve water quality. Since 1995, as part of the Tributary Strategy process, DWSC has recorded the reduction in amounts of nitrogen and phosphorus resulting from the installation of BMP's. Between 1985 and June 1999, farms in Clarke County have reduced the amount of nitrogen by 29,962 pounds and phosphorus by 4,540 pounds that would have entered the County's

Figure 14


Chesapeake Bay Preservation Areas
340
7
340
17
50
River/Lake/Pond
Resource Protection Areas (5,165 acres)
Resource Management Areas (18,025 acres)
Roads
County Boundary
0
Inches
1
0
Miles
2.5
N
THE COUNTY OF
CLARKE
VIRGINIA 1836
Clarke County GIS
April 6, 1999
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waterways. This level of participation provides a clear indication that the farming community is interested in and has had a significant impact in protecting the natural environment.

In addition, the County has adopted specific ordinances that protect both ground and surface waters from urban source pollution. These include the County Septic, Well, Sinkhole, and Erosion and Sediment (E&S) Control Ordinances. The County Septic Ordinance requires increased siting requirements that exceed current State requirements and installation of a 100% reserve area and sets forth provisions for mandatory septic pump-out. The Well Ordinance increases standards for grouting and casing and establishes setbacks from known sources of pollution. The Sinkhole Ordinance serves to increase awareness of the potential to contaminate groundwater through sinkholes and imposes penalties for illegal dumping. The E&S Ordinance establishes a minimum disturbance area of 2,500 square feet that may require an E&S plan approved by the Division of Soil and Water Conservation.

The County has added sections to the Zoning Ordinance that require a minimum 100-foot building setback to perennial streams and springs, 50 feet to intermittent streams, and minimal clearing within these setback areas in the Forestal -Open Space -Conservation (FOC) District.

The County has also explored the possibility of installing zero discharge waste water treatment facilities in the County to dispose of septage and sewage. Approximately 60,000 gals./day could be processed and the effluent used as irrigation water rather than being discharged into area tributaries.

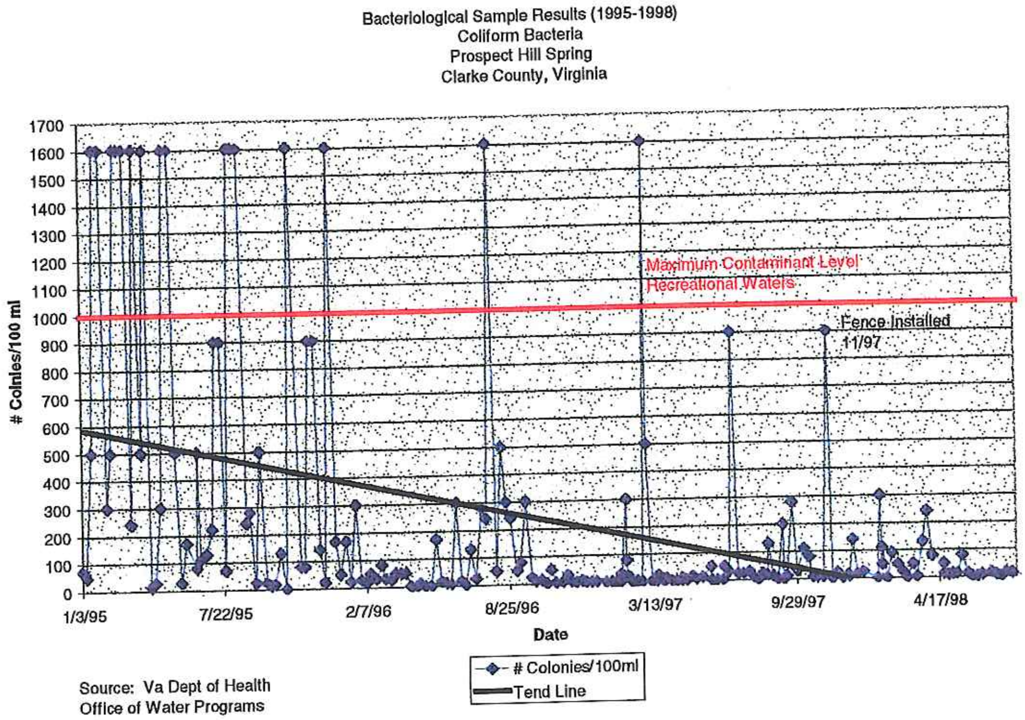
Watershed Protection Efforts

Two EPA Section 319 grants and one Water Quality Improvement Fund (WQIF) grant requests have been funded to improve water quality within the Spout Run watershed. Spout Run is a priority watershed for the County, because Prospect Hill Spring is within this basin and serves as a public water supply for 300 households. This spring has recently been determined to be under the influence of surface waters and therefore must comply with EPA's Surface Water Treatment Rule. Both the Clarke County Planning Commission and Sanitary Authority have determined that overall watershed protection is critical to maintaining the viability of this Spring as a public water supply. Recent efforts to reduce coliform bacteria in the Spring have included acquiring a 7 acre buffer area upslope of the Spring. This area was fenced, and 400 hardwood seedlings were planted in 1997. That effort has resulted in a significant decrease of coliform bacteria present in the Spring (figure 15). This outcome further highlights the effectiveness of vegetative buffers in protecting water quality.

In addition, as indicated previously, the Shenandoah River/Spout Run watershed has been identified as a high priority in the Statewide Nonpoint Source Pollution Potential Priorities and Impaired Waters Listing and Natural Heritage Priority Ranking for 1996. The watershed is also listed as a TMDL priority, as impaired water, the source of impairment being listed as NPS agriculture. Spout Run has a medium Natural Heritage Ranking.

The first EPA grant was for Page Brook, a tributary of Spout Run. This project was initiated in 1996, with receipt of $75,000 to conduct a watershed study, which examines practical approaches of BMP installation to improve water quality. Approximately 2.5 miles of fencing was installed on four farms in the watershed. The effectiveness of the BMP installation was determined by analyzing water samples collected monthly throughout the project. Dr. Charles Hagedorn, a professor in the Soil and Crop Environmental Sciences Department at Virginia Tech, analyzed fecal coliform bacteria. After analyzing the data, he concluded that coliform bacteria counts collected at sites within fenced buffer areas were reduced by an average of 92% from August-October 1997 to August-October 1998. Initially, coliform bacteria counts were at levels high enough to declare the stream impaired, but since fencing and other BMPs have been installed, coliform levels have been reduced below the impairment level. Final reports and conclusions of this study will be available in early 2000.

Figure 15. Water sampling results, Prospect Hill Spring, Clarke County, Virginia.



A second EPA grant was approved in 1998 for Roseville Run, the other main tributary of Spout Run. This grant was for the amount of $65,250 to improve water quality in this section of the watershed by installing BMPs similar to the work conducted in Page Brook. A WQIF grant request for $45,150 was also funded to improve water quality in the main stem of Spout Run. This study will emphasize stream fencing but will also address the impact that failing septic systems and discharge of sewage treatment plants have on water quality.

VII. PLAN IMPLEMENTATION

Clarke County has already initiated efforts to improve surface water quality as described above. However, more can be done to address threats to surface waters. The following is a list of recommended actions to improve surface water quality, in order of priority.

1. Establish a Stream Protection Overlay District and adopt regulations to protect those designated areas.
The Chesapeake Bay Act requires Tidewater counties to implement the Chesapeake Bay Preservation Area Regulations to reduce nutrient loading in the Bay. Localities outside of the coastal areas are encouraged to implement components of the Act that will be most effective in reducing pollutants entering tributary streams that ultimately enter the Bay. Clarke County should adopt an overlay district described as the Stream Protection Overlay District. The intent of this district is to provide stream buffers for the purposes of filtering nonpoint source pollution from runoff, preventing erosion, moderating stream temperature, and providing for the ecological integrity of stream corridors and networks. The establishment of the district will encourage the long-term protection of surface waters and help to prevent the contamination of groundwater, the principal source of drinking water in the County.

2. Amend the Zoning Ordinance to require 100 foot building setbacks from perennial streams and springs, and 50 foot building setbacks from intermittent streams identified on the 7.5 minute USGS topographical maps within the Agricultural –Open Space - Conservation District.
Preserving stream and river riparian corridor zones is essential for protecting water quality. Building setbacks from streams have been in place in the FOC zoning district since 1994. Requiring these same setbacks in AOC will serve to protect stream corridors in the Valley region of the County.

3. Establish a Countywide surface water monitoring network to effectively monitor changes in water quality over time. This program would include routine testing of and official reporting for all perennial streams for coliform and water chemistry.
Several streams in the County are currently monitored, but most are not. Identifying which streams are contaminated is necessary to allocate limited resources effectively.

4. Encourage upgrading of sewage treatment plants to reduce nutrient discharge into surface waters.
In general, wastewater treatment plants contribute a significant amount of nutrients to State waters. Past discussions in the County have involved upgrading the Boyce treatment facility to reduce nutrient discharges. Upgrades may include zero discharge or land application, biological nutrient removal (BNR) treatment, or other methods. Over time, these upgrades would have a considerable impact in the reduction of nutrients entering the Shenandoah River Basin. In addition, the County should encourage and support the Town of Berryville when upgrades for the Berryville Treatment Facility are considered.

5. Encourage installation of Best Manangement Practices (BMPs) to reduce livestock access to riparian buffer zones.
Efforts should be directed at working closely with the Soil and Water Conservation District to encourage use of Cost-Share Programs on a farm-by-farm basis. Priorities established as a result of other planning efforts detailed in this report will aid in focusing limited resources. Two important County roles would be to increase awareness of the nonpoint source (NPS) problem

determining groundwater flow patterns. Surface waters can also be tested to determine the extent of interaction within drainage basins. In addition, flow discharge measurements can be utilized in identifying flow rate losses to groundwater within streams. Concentrated efforts should be initiated within the Spout Run watershed to help further define flow patterns to Prospect Hill Spring.

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